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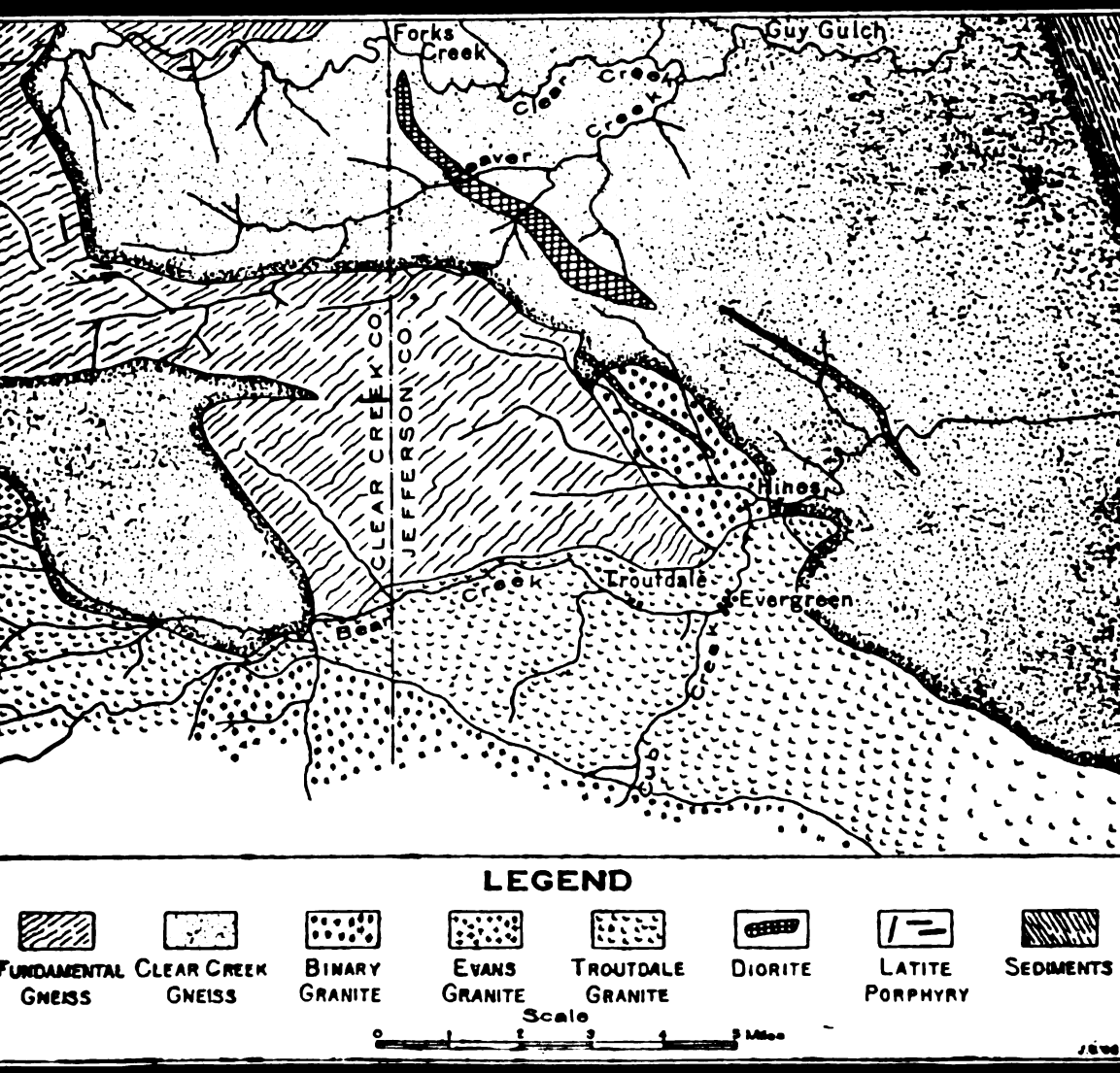

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THE UNIVERSITY OF COLORADO STUDIES

VOL. III

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

NOVEMBER, 1905, TO AUGUST, 1906

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PRINTED AT
THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

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SOCIOLOGICAL EFFECTS OF THE TRUST

By John Burton Phillips

It is proposed in this paper to point out some of the effects on society of the trust method of conducting industry. No attempt is made to discuss the trust problem as a whole, nor to explain the economies in production that result from the formation of great industrial combinations. The effect of trusts on the prices of commodities is not considered. Aside from these particulars, there are certain important features in the operation of industry by great combinations that are well worth considering. There are improvements in modern business life that have resulted from the destruction of the small dealer and the organization of the business on a large scale. Since the decision of the Supreme Court in the Northern Securities case, so much feeling against every great combination has been stirred up that it may not be amiss to mention some of the services the organization of industry on a large scale has rendered to society. While the trust has brought many evils in its train, and while it is probable that a number of these combinations should be destroyed, it is perhaps wiser to seek for some method to regulate them than loudly to demand their entire abolition. A careful consideration of the manner in which they affect society will enable one to form a more intelligent opinion as to the best methods of dealing with this difficult problem.

Among other things, the trust has increased competition among its employees, eliminated the rule of the obstinate man who hindered progress, created new and high-class opportunities for specially gifted men, brought about a saving of social energy and a greater degree of specialization, provided a more speedy means of promotion according to merit, improved the moral tone of those it employs, and taught the world to undertake great enterprises.

The progress of civilization has been marked by increase of competition. In this way the right man has been selected for the place he could best fill. This is a great saving of social energy. The tendency is to eliminate the inefficient man. No society can afford to have its

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men with a talent for baking kept at the business of making clocks, nor its men with capacity for clock-making working in a soap factory. By eliminating the effect of family and other influences in industry, and placing each man in a position according to his ability, and making his tenure and promotion depend upon his efficiency, the trust has greatly increased the opportunities for competition. Here is a quotation from Bridge's *Inside History of the Carnegie Steel Company* showing the methods adopted by that company, and in all probability still kept up by the United States Steel Corporation:

A workman was building a heating furnace. "There goes that —— bookkeeper! If I use a dozen bricks more than I did last month, he knows it and comes around to ask why." This was no exaggeration. The minutest details of the cost of material and labor in every department appeared from day to day and week to week in the accounts, and soon every man about the place was made to realize it. The men felt, and often remarked, that the eyes of the company were always on them through the books. If the workmanship was exceptionally good and the output of a high average, which was insisted upon, the head of the department received a letter of congratulation, and perhaps a present at Christmas time. If it fell behind either in quality or output, the fact was promptly brought to his notice and Captain Jones would see if the fault lay in the machinery; if it did, he generally knew how to remedy it. If the defect was in the human machine and reproof did not suffice to correct it, the man was replaced by an understudy, which Captain Jones usually had trained in view of such contingencies.[1]

The trust has a great advantage in the selection of its manager. Some men excel in organizing industries and in finding the work for which each man is best adapted. The great problem of modern industry is to find these men. A trust has a number of separate plants and each plant has its manager. Each manager is pitted against and compared with the others, and the most capable one selected to be the general manager of the entire trust.

Again, by this fierce competition between the trust's various plants the output is increased. The plants are matched against each other. Each man knows his work is measured by the work of some other man in another and similar plant. This knowledge makes him put his utmost energy into what he is doing. Such results are impossible in industry conducted on a small scale.

[1] Bridge, p. 85.

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Much has been said about the destruction of individual liberty by the action of the trust. It is true that the gigantic production which results from the combination of many industries into one does destroy the opportunity for the small dealer to start an independent business. But this may happen without injuring industrial liberty. Industrial liberty does not mean freedom to carry on a business without interference. Like political liberty, it is a positive thing which results from the operation of law. The law is the expression of the desires of society. If the small dealer cannot render as great a service to society as those who conduct industry on a large scale, he has no right to complain if society does not guarantee him an abundance of opportunity to do business in a small way. Any society would be unwise to use its strength to maintain conditions favorable to the smaller industrial units when their combination would result in a saving of human energy in the production of those commodities which supply the communities' material needs.

The greatest good of the greatest number has always been the motto of modern progress. This is as true industrially as in any other respect. Industry should be so carried on that the greatest number of men conducting it may have a controlling voice in its management. This is the only way in which democracy in industry can be secured. A little reflection will convince anyone that in cases where the proprietor is managing his own business his obstinacy often stands in the way of progress. Some men are by nature opposed to many things the majority want. When such men are doing business in their own way, they are often able to block needed reforms. In his address before the American Economic Association in 1901, Professor Ely points out such a case among the barbers in the city of Madison. At that time there were twenty barber shops in the city. Of these nineteen wanted to close on Sundays. One was opposed to Sunday closing. The result was that they all kept open. Here was a case where one obstinate person was able to check a needed reform. One man poor in public spirit was able to rule nineteen better men. This is not an uncommon thing in the business world.

There are many factories in the hands of obstinate and unscrupulous

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men. By working their employees long hours, or by employing women and children, they force other and better-disposed men to resort to the same bad practices, since the public will not stop to inquire about the conditions under which goods are made. Any unscrupulous method resorted to by one employer tends to extend itself to all employers in that industry. Thus the individual method of conducting industries tends to reduce them all to the level of business morality represented by the most unscrupulous manager. Now, suppose the various firms, or, as in the above case, the barber shops, combined into a trust. Each shop or firm takes stock in the trust, and the business is carried on by a manager. The policy of the business is determined by the votes of the firms composing the trust. It is decided by a majority vote. In this way the nineteen barbers that desired to close on Sundays, and the manufacturers that were opposed to the employment of women and children, might make their influence felt in the conduct of industry. At any rate, the influence of the unscrupulous man in business would be greatly reduced.

In the popular enthusiasm for opportunity for the small dealer the public often loses sight of the incidental benefits that result from the magnitude of an industry. When manufacturers have succeeded in producing a valuable article, they are not content to manufacture it without the effort to improve. The public demands more than a static condition of industry. To live and flourish, a manufacturing concern must constantly improve its productions. In order to do this, the great establishments of the country are employing physicists, chemists, inventors and experimenters of all kinds. Large manufacturing druggists employ many men continuously to make experiments and discover new remedies, in order that they may be able to put the newly discovered drug on the market and reap the financial reward. One such company has had a man working for several years to find a remedy for the cure of rabies. What is true of large drug companies is also true of great industries generally. The larger the industry, the greater the number of inventors and experimenters constantly employed.

The small firms or individuals that are carrying on any of these industries cannot employ inventors or specialists of any sort. They are

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doing business on too small a scale to be able to afford it. Their profits are too small, and it is not possible for them to increase them without increasing their plant to a great magnitude. They are therefore doubly handicapped. The trust is able to secure the services of specialists and profit by the discoveries they are able to make. Great establishments do not employ specialists solely because they fear competition. They are employed fully as much to secure the benefits that may result from more economical processes as to gain an advantage in a competitive market. This being the case, it is not probable that there would be less employment of such persons even if the trust had a complete monopoly of the market.

It is clear from this account of the manner in which modern manufacturers are working for the improvement of their respective products that they have opened a new field of employment. In the early day there was no opportunity for the man who had the genius to invent or discover. He had to work amid the surroundings of poverty, and society often lost entirely the benefits that might have resulted to it from the labors of these specially gifted individuals. Such, however, is no longer the case. Any man with inventive power is able to find a place in the employ of a large firm where, in laboratories provided by the employer, he is able to make discoveries that will add greatly to the health and happiness of the race. In this way it appears that society gains most when its industries are conducted on the largest practicable scale.

It is quite true that the trust is enabled to dispense with the services of a great number of commercial travelers, but this is a social gain. It is also true that the advertising feature of trust-conducted industries is reduced to a minimum, but this is a gain when considered from the point of view of social welfare. The more men a society must employ in the distributive industries, the more wasteful is its organization. Every reduction in energy needed to bring goods from the producer to the consumer is an advance in industrial progress. If the entire population might engage in production, there would be a great increase in well-being.

A great deal has been written about the subordinate position of a

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man who has always to work for a gigantic corporation. It is said that this will destroy individual initiative. In all probability this has been very much exaggerated. There would seem to be little reason for the belief that a man will not have the opportunity to show the same amount of ingenuity in working for the trust that he would have in working in an establishment owned by himself. Suppose a man is intrusted with the duty of working up trade for a great corporation, as, for example, the development of a taste for chewing gum among the Japanese. Mr. Flint testified before the Industrial Commission that the American Chicle Company were endeavoring to cultivate such a taste among the Europeans. Here is a field demanding all the originality that any man possesses.

It is not to be expected that all men should have the chance to develop industries in their own way. This is impossible. It is given to a few men to be leaders in politics and government. The others are glad enough to follow them. So it is in industry. Few men are capable of originating new things. There is no reason why society should insist on keeping industries small for the sake of allowing inefficient men to try to manage them. In this way these men waste social energy. This opportunity had better be taken from them. Some men think they can practice medicine without medical study. Society has declined to give them the opportunity. They must first prove their ability to practice skillfully the healing art. So it may be better for one first to prove his ability to manage a great business before he is allowed to experiment and fail at the expense of society. What society needs in the organization of industry is the prevention of the enormous wastes that are now so common, and if, by leaving this matter to the industries organized on a large scale, a great social saving can be made, there is no reason why it should not be done.

The destruction of some opportunities for private initiative is not a serious thing. If societies can manage more successfully industries that have been previously left to private parties, it is wise that the society undertake these enterprises. No one criticises the management of the postoffice by the government. This kind of governmental activity increases instead of curtailing the opportunities of individuals. Govern-

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ment ownership of railroads tends to take away great opportunities for the investment of private capital, but, at the same time, may make it possible for the private investor to use his capital in different ways, and in ways that he is now prevented from using it by discriminating rates. It is well known that at the present time in many parts of the United States industrial development is greatly hindered by the freight rates that have been established by the railroads. Governmental regulation of rates might interfere with private rights in the railroad business, but might also open for investment many new opportunities in the localities that are now checked in their development by discriminating freight rates.

The trust and corporation forms of industry tend to increase opportunities for promotion according to merit. When business is conducted by a manager, as is the case in the corporate form of industry, the aim is always to secure greater efficiency in the employees. A man's position depends more upon his ability to do his work well than on his pull, or on his relationship to the head of the firm or to one of the partners, as was the case under the old method of management. Formerly the boy was taken into his father's or uncle's store or factory, and, even though more or less inefficient, was often continued in the position when the more efficient clerks were kept in subordinate places. In this way the sons have often dwindled along and made a living from the mere inertia of the business.

Under the trust this is all very different. The father's and uncle's business is no longer in their hands. It is in the hands of the manager of the trust, and he desires only to earn dividends for the stockholders. Anything that in any way tends to interfere with this is not likely to be tolerated by him. He will therefore have in his employ only the most efficient workmen. To get them he will select persons according to their fitness for the work. The boy who has no other qualifications except that he is the son of his father will not be able to work for the trust unless he can show by his ability that he is more efficient than some one else would be. Because of this the poor boy with ability is not so apt to be hindered in his promotion. Thus industry becomes more democratic.

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The trust system of industry, working as it does wholly on the competitive method, is tending constantly to elevate the moral tone of its employees. As long as the trust asks of them only the question, "Are you efficient?" it is putting a premium on everything that tends to increase ability. The things that are constantly tending to increase ability are honesty and good habits. The man whose habits and character are such as to make him in any way less capable is very soon dismissed. The employee of the great corporations must be sparing in his use of liquors, if he uses them at all. He must not carouse nights. He must come to his work with a rested body and a clear brain. The great railroads have found that they cannot afford to keep intemperate men in their employ. They have issued orders to their agents to employ only temperate men.

The psychological effect of great industries upon national development should not be underestimated. A people among whom are carried on industries like those conducted by the Standard Oil Company, the American Sugar Refining Company, and the United States Steel Corporation will not be thinking of small things. Such a people has passed the stage of industrial evolution when traders thought only of selling in the local markets.

The American people are accustomed to think of great things in industry. The conduct of great businesses has added a certain stimulus to their intellectual operations. This is one of the distinctively American traits that place our people in a different class from those of European countries. So common to us is the idea of magnitude in business that as great an enterprise as the construction of the Panama Canal is regarded as a matter of course and undertaken with comparatively little discussion.

This characteristic of our people has greatly increased since the close of the Civil War. That war was a great influence in educating the American people to the knowledge of their own powers. War always awakens the nation which wages it to a realization of its capacity for great enterprises. It is not strange that this should be the case. When a nation is able to organize, discipline and maintain for a number of years an army of several hundred thousand men, a great deal of executive ability will be brought to light. When the war is over, these

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men whose executive ability has been tested do not readily turn their attention to small industries. In fable and fiction, Cincinnatus may leave his plow, lead his countrymen to glorious victories, and again return to rural pursuits; but real human nature does not often act in this way. After the Civil War great industrial schemes were conceived. Railroad-building gave opportunity for the exercise of great administrative genius. When men conceived and executed plans for building railroads from Chicago to the Pacific, other industries were thought of in the same proportion.

The desire to dominate and excel is one of the most fundamental traits of human nature, and its exercise in the industrial field is one of the best signs of the higher civilization. In countries where there are no great industries, men born with the desire for leadership and domination have but one direction in which to turn their energies, and that is revolution. Industrial opportunity for men of great organizing ability is, therefore, a certain guarantee of the political stability of a nation.

Such are some of the more important effects on society when industry is conducted on a large scale. Since they are such as tend to the improvement of social conditions, careful study should be given to methods of controlling great industrial combinations. It is probable that the high prices maintained by trusts at the present time more than counterbalance the advantages enumerated in this paper, and unless some means of controlling these great industries can be found, their destruction should be insisted upon.

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THE TERRITORY OF JEFFERSON: A SPONTANEOUS COMMONWEALTH[1]

By Frederic L. Paxson

A great western scholar has well emphasized the significance of the frontier in the development of American history. He has pointed out the fact that the conditions of life along the edge of the wave of population moving to the West have been more nearly stable and uniform than those of any other portion of the United States, and that the men produced in this frontier have been a constant and positive force in the development of national life. But the time has been too short and the laborers too few for the vast field of western history to have received more than a most superficial treatment, and so it is that the searcher in this field comes daily to his rich reward. It was here that the territory of Jefferson lived and passed away.

In January of 1859 some grains of gold were brought to the Missouri River to prove to the world that a great gold field had been overlooked in the rush to California. For more than ten years the busy trails to Santa Fé and Oregon had carried their thousands past the fields of Colorado to the coast; but now the movement changed, and active life sprang into existence at the forks of Cherry Creek and the South Platte, while a restless population, hungry from the panic of 1857, filled the new mining camps of Colorado.

The mining camp at its best affords a problem in government, at its worst a study in anarchy; and these new camps at Auraria and St. Charles and Central City were no exceptions to the rule. In a legal way, the camps straddled the line of the fortieth parallel that then divided the territories of Kansas and Nebraska. But they were five hundred miles from a seat of government, and no political organization had ever been effected in their district. They needed law and civil rights and justice, but they had only the territorial organizations of a bleeding Kansas and an impotent Nebraska.

[1] A paper read before the Section of American History of the International Congress of Arts and Sciences, St. Louis, September, 24, 1904.

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The first miners had reached the South Platte in the autumn of 1858. They realized their political opportunity, so that when a snowstorm drove them to cabins for a day or two, they emerged with a determination to demand a new state for the Pike's Peak region and to send delegates to Washington and Kansas. The spring of 1859 saw more statehood gossip, more delegates, and the arrival at once of a new population, a printing-press and a political platform. "We claim," wrote the pioneer editor of the *Rocky Mountain News*, "that any body of American citizens, which from any cause or under any circumstance, is cut off from, or from isolation is so situated, as not to be under any active and protective branch of the central government, have a right, if on American soil, to frame a government, and enact such laws and regulations as may be necessary for their own safety, protection, and happiness, always with the condition precedent, that they shall, at the earliest moment when the central government shall extend an *effective* organization and laws over them, give it their unqualified support and obedience." I have found no other statement so definite as this, that an American community has a right to an effective government.

An election of delegates to represent the Pike's Peak country in the legislature of Kansas and the halls of Congress was held early in November, 1858; and four months later the district organized itself as Arapahoe County, Kansas, although no such county possessed a legal existence. But the movement for an independent statehood was gaining force day by day, as the immigration of 1859 brought its thousands of gold-seekers into Denver. It culminated at last on the 11th of April, 1859, in a caucus, and on the 15th in a convention of delegates from five of the mining camps that issued a call for a constitutional convention to meet in Denver on the first Monday in June to frame a constitution for the State of Jefferson, between the 102d and 110th meridians and the 37th and 43rd parallels of north latitude. The miners proposed to rob the territories of Kansas and Nebraska, of New Mexico and Utah, to endow their own state.

Pursuant to the call, a convention met in Blake and Williams' hall in Denver on June 6, organized for business, created eight framing committees, and adjourned for two months that the idea of statehood

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might develop. On the first of August it convened again to spend five days in the double work of framing a constitution and deciding whether to apply for state or territorial existence. Unable to choose between the alternatives, it evaded the decision by presenting at once a constitution and a territorial memorial, and referring the matter to popular vote. The election on September 5 rejected the constitution for the State of Jefferson.

Thus far the movement for a local organization had failed—while the need for it had become greater every month. But before September came to an end a call had been issued for another convention to frame a provisional constitution for the Territory of Jefferson. And on the 7th of November this movement terminated when its constitution was made effective, its legislature met for a first session, and Robert W. Steele, of Ohio, its first governor, read his inaugural message.

The Territory of Jefferson was an illegitimate commonwealth. It came spontaneously when the need for it was felt; and so long as it endured, it lived in defiance of the laws of Kansas and Nebraska, and without the sanction of the United States. Yet its life covered a year and a half. Its governor was twice elected; two legislatures met to transact its business; its courts were organized and respected; and it was only when it tried to collect its revenues that it showed its weakness. But for several months it was an effective instrument in the preservation of order and law, while its corporate existence was terminated when Congress in the spring of 1861 created the Territory of Colorado, and Lincoln appointed William Gilpin to be its governor. Then the old organization lived up to its platform, as it resigned its powers into the hands of the lawfully constituted authorities.

The Territory of Jefferson is only an episode in the process of commonwealth-building in the West. But it illustrates the constant quality of frontier citizenship and the spontaneous instinct for self-government that give to American life so much of its distinctive character. It was a government that originated in necessity; that, although illegitimate, bore every earmark of a reign of law; that served a useful purpose, and that died an honorable death after a not unhonorable life. "If there be any vestige of power yet remaining in the Provisional

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Government of Jefferson Territory," proclaimed Governor Steele at the end of his career, "I, as its chief executive, would advise and counsel our citizens to remain loyal and firm to that old flag that has protected us from our infancy. Pay your debts when you can, live honorably with all men, but love your country and its flag even unto death, if required."

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THE HISTORICAL OPPORTUNITY IN COLORADO

By Frederic L. Paxson

There is great danger lest the teacher of history in the far West should bewail the thousand odd miles that separate him from the source material of his profession, and so overlook the opportunity that lies at his feet. He is too liable to forget that the parallel to the course of his own country has rarely, if ever, been seen; that the external facts of the history of the West show to the thoughtful worker a field of amazing richness, and that the internal facts, so far as they have been exploited, confirm the first impression. The chance to investigate the workings of a civilization which in less than half a century has passed from wilderness through frontier and pioneer conditions to order and wealth is what he ought to see before him. And the opportunity to work out the causes and results in this concentrated life is his historical opportunity.

It is useless for the student of history in Colorado to mourn over the absence of great libraries. He may as well admit the fact that the historical library is a product of generations, and that, save for two or three working collections of various degrees of incompleteness, such a library is not within his reach. If he be a worker in any field of general history, be it European, mediæval, ancient, or even American, he must be content with a few secondary authorities. He cannot hope, even with access to all the libraries in the state, to produce a piece of original work that will add anything to the knowledge of the world. But if he admit this fact, and settle down to the belief that no productive work in history can be done in Colorado, he will overlook in the local field a historical opportunity that is hardly to be equaled in the United States.

The beginnings have been made in the writing of the history of Colorado, but the journalists have thus far monopolized the work, and it is only today that the trained historical scholar is coming to weigh the evidence and record a critical judgment. A small number of general works must be considered by anyone who undertakes to study the

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history of the state; the production of monographs has begun, and new studies are appearing in increasing number; while the collection of the raw material for future studies is fairly well advanced.

The histories of Colorado begin with Hollister's handbook for miners,[1] published in the sixties and containing a brief sketch of the growth of the territory. Most of them have followed this work, accepting its conclusions and giving to it more or less credit. Fossett,[2] in his work of a decade later, is much indebted to his predecessor; and the monumental work of General Hall[3] is based upon the foundation of Hollister, supplemented by a knowledge of newspapers and the copious memory of one who was more than a spectator in the early days of the territory. The pages of Bancroft[4] on the state show a knowledge of the same source, while those of Byers[5] show the same indebtedness, reinforced by the memory of an active pioneer.

In a less general sense, Hollister is still used as a source, but the local antiquarians have provided much material for the future historian. Such books as those published by Baskin & Company of Chicago[6] for the subscription trade are by no means to be disregarded. Boyd's *History of Greeley*[7] is rich in documents and economic details. The biographical subscription works[8] record personal details for many a valuable footnote. And Smiley's *History of Denver*[9] is a conscientious attempt to tell the story that has had a large measure of success. It is the best of the works in print on the history of Colorado.

[1] OVANDO J. HOLLISTER, *The Mines of Colorado* (Springfield, Mass., 1867).

[2] FRANK FOSSETT, *Colorado: A Historical, Descriptive, and Statistical Work on the Rocky Mountain Gold and Silver Mining Region* (Denver: Daily Tribune Steam Printing House, 1876).

[3] FRANK HALL, *History of the State of Colorado* (4 vols., illustrated; Chicago, 1889).

[4] HUBERT HOWE BANCROFT, *History of Nevada, Colorado, and Wyoming, 1540–1888* (San Francisco, 1890; Vol. XXV of his *Works*).

[5] WILLIAM N. BYERS, "History of Colorado," in *Encyclopedia of Biography of Colorado*, Vol. I (Chicago: The Century Publishing and Engraving Company, 1901).

[6] *History of the City of Denver, Arapahoe County, and Colorado* (Chicago, 1890); *History of Clear Creek and Boulder Valleys, Colorado* (Chicago, 1890); *History of the Arkansas Valley, Colorado* (Chicago, 1891).

[7] DAVID BOYD, *A History of Greeley and the Union Colony of Colorado* (Greeley, Colo., 1890).

[8] See the *Encyclopedia of Biography*, noted above, and *Portrait and Biographical Record of Denver and Vicinity, Colorado, Containing Portraits and Biographies of Many Well Known Citizens of the Past and Present, Together with Biographies and Portraits of All the Presidents of the United States* (Chicago, Chapman Pub. Co., 1898).

[9] JEROME C. SMILEY, *History of Denver, with Outlines of the Earlier History of the Rocky Mountain Country* (Denver, 1901).

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It may be said that the outlines of the history of the State have been defined in a superficial way, and that personal recollection, strengthened by an uncritical use of newspapers, has done as much as can be expected of it. The next step, which is the production of critical monographs on details of the history, is now being taken. The learned institutions of the state are showing a consciousness of their duty in respect to the local problem,[1] while the neighboring states that once embraced the territory of Colorado are aiding in the work,[2] and individuals within the state are doing something in the way of publication of personal reminiscences.[3]

As a means for aiding this production of monograph literature, the gathering of source material has not only been begun, but has resulted in at least two valuable collections of Coloradoana. The sources for the history of Colorado are to be found in several different classes, none of which may be neglected by the student. The documents of the state, which form the foundation for the legal portion of the history, include the printed statutes, journals and reports of both state and territorial periods, and the great mass of unpublished manuscript records which are to be found in the archives of the Capitol and the counties.[4] The statutes, documents and debates of Congress also throw much light on special phases of Colorado history. In the matter of non-official sources, the newspapers lead the way, subject always to the limitations upon material of this sort. The mistakes of both head and heart which abound in the daily press do not destroy its source value, but certainly do impose upon the student the necessity for more care and higher degrees of criticism than do any other of our modern sources. Personal recollections, biographies and other private works add greatly to the source material at the disposal of the scholar.

[1] ELMER H. MEYER (of the University of Denver), "The Constitution of Colorado," in *Iowa Journal of History and Politics*, Vol. II, pp. 256–274; FREDERIC L. PAXSON (of the University of Colorado), "The Boundaries of Colorado," in *University of Colorado Studies*, Vol. II, pp. 87–94; B. M. RASTALL (of Colorado College), "The Cripple Creek Strike of 1893," in *Colorado College Studies, Social Science Series, No. 5*, June, 1905, pp. 1–48.

[2] HELEN G. GILL, "The Establishment of Counties in Kansas," in *Kansas Historical Collections*, Vol. VIII, pp. 1–23; W. J. SPILLMAN, "Adjustment of the Texas Boundary in 1850," in *Quarterly of the Texas State Historical Association*, Vol. VII, No. 3, pp. 177–195.

[3] *Early Day Letters from Auraria (now Denver) Written by Libeus Barney to the Bennington Banner, Bennington, Vermont, 1859–1860* (n. d.).

[4] F. L. PAXSON, "The Public Archives of the State of Colorado," in *Annual Report of the American Historical Association for the Year 1903*, Vol. I, pp. 415–437.

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The most notable collection of materials for the history of Colorado is to be found in the private library of the president of the State Historical and Natural History Society, Mr. Edward B. Morgan, of Denver. This collection is the result of a prolonged search for books and pamphlets written about Colorado, in Colorado or by Coloradoans. Its bound volumes go above five hundred, while its pamphlets run into the thousands. The labors of Mr. Morgan are being supplemented today by those of Mr. W. C. Ferrill, curator of the same society. The files of newspapers and the bundles of photographs gathered by him and guarded in the vaults of the Capitol form a nucleus for a great historical library at some future day.

This much has been done toward the writing of the history of Colorado: the general outline has been sketched, a few minor points have been cleared up in careful monographs, and the gathering of source material is progressing as rapidly as public and private means will allow. But this is only the beginning of the work that calls today for more laborers than the state has ever provided. In whatever field the local historian may choose to work, he can find the ground practically unbroken and the opportunity complete. It makes no difference whether he choose to investigate workings of the institutions of the state and the general activities of its government, or the development of local county or municipal institutions, or the larger problems of transportation, irrigation or politics that connect the state with its neighbor commonwealths and the United States. In every direction he may advance with the assurance that his contribution to history will be limited only by his industry and ability. The historical opportunity of Colorado lies in this field.

The central government of Colorado tempts the historical worker because of its rapid extension, highly concentrated in point of time. A period of forty-five years covers the whole of Colorado history, and and in this period there has developed, out of the barren frontier that had been the Great American Desert, a modern commonwealth with its various political, economic and social activities. Growth that has occupied a century in older states has occurred here in a generation, while in many directions the growth has been almost unique. A high-

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school system with 83 per cent. of its instructors college graduates calls loudly for a historical explanation. A universal application of irrigation law gives a distinctive color and emphasis to legal history; while the relation of a state government to the control of mines can be studied here in all its aspects.

The field of local institutional history has never been worked to its extreme capacity in the United States. Much has been done in the far East, but even there the study has been fragmentary, and has been embarrassed in many cases by the historical remoteness of the origins. Throughout the West in general this remoteness does not exist. In Colorado it is still possible to supplement the documentary evidence as to historical beginnings with the recollection of historical participants. And the fact that the growth has been unduly rapid gives an unusual degree of continuity to the institutions. There is not a town or community in Colorado but has some economic or political reason for its existence and needs its careful historian. The mine and the watershed are still to be measured and estimated in their influences upon place and form of social life.

Transportation is perhaps the most significant element in the history of the West. It not only constitutes a large part of the cost of every commodity in use, but it possesses the power to build up or to destroy whole communities. Yet no one has written adequate histories of the wagon routes from the Missouri to the Rockies which made Colorado possible; no one has exhausted the subject of Federal policy towards continental railroads and public lands;[1] no one has even broken the ground in the deveplopment of transportation by road, trail, steam and electricity within the state. All these fields are crying for some one to exploit them.

The opportunity thus opening in Colorado makes it possible for every student of American history to do something in the field of historical research. Every topic that he works out strengthens himself, and every article or note that he prints makes smoother the path of his colleagues. Whether he work in connection with a great educational

[1] Two of the *Bulletins of the University of Wisconsin* reveal the possibilities in this general field. JOHN BELL SANBORN, "Congressional Grants of Land in Aid of Railways," *Bulletin No. 30* (Madison, 1899); JOSEPH SCHAFER, "The Origin of the System of Land Grants for Education," *Bulletin No. 63* (Madison, 1902).

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institution, or in a local school, or in the privacy of his own study, the opportunity is the same. It is the chance to write a history that is yet fresh from the making and that presents its materials close to every hand.

Particularly in the case of the local schools is the opportunity attractive. For the senior year in the high school the ideal course in history is based on American history and civil government. It is thus possible, in the case of that majority of students whose scholastic education is now in its completion, to fill the mind with the actualities of local life. The mayor and the alderman possess a new interest when the student applies his theory of civics to the workings of his town. And if he thus realize the difference between the theory and practice, he is made thereby the better citizen. The basis of American history is more clearly understood if he identify some of its conditions as they have appeared in the making of his own community. And, fresh from this last year of the high school, he is thrown out into his later world with history and politics as real things, not as shadowy phantoms. From a practical standpoint of public morality, no man who has once learned to look historically upon his local government is likely to place himself in an embarrassing historical attitude. The judgment of the daily press is commonly personal or political—mistaken in either case—but the estimate of history must, in the long run of events, be right.

The student, the teacher, and the man in the street are only just beginning to appreciate the significance of the historical position of Colorado and the Rocky Mountain region. "Here,"[1] writes one of the workers, "is the virgin soil almost untouched by the student or the historian. Here, too, it is possible to study the frontier at close range, and to carry out for states and sections that magnificent line of research work which Professor Turner of Wisconsin and others are doing so admirably for the country as a whole."

[1] Professor Thomas K. Urdahl, in "Introduction" to Rastall, *Cripple Creek Strike of 1893*, p. iii.

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HUMAN INFANCY: ITS CAUSES, SIGNIFICANCE, AND THE LIMITS OF ITS PROLONGATION

By Joseph Hershey Bair

By a study of comparative psychology and anatomy it will be found that there is a correlation between higher mental functions and the size of the cerebral hemispheres of the brain. As memory, discrimination and the power to learn by experience, as well as all the higher psychical factors, develop in animals, so does also the size of the cerebral cortex. In the primitive vertebrates the cerebrum and cerebellum do not exist as separate structures. In fishes they are very small. In the halibut, e. g., a fish weighing over one hundred pounds, the cerebral hemispheres are no bigger than peas, not nearly as large as the optic lobes. In birds and mammals the cerebrum becomes more and more conspicuous, until in the higher apes the brain pushes forward. This same process is continued in man until it attains its normally enormous size. The size of the cortex also increases by a process of furrowing which makes its area almost four times as great as if it were smooth. The higher up in the series we go, the deeper and more numerous these folds become, and these, too, are an index to general intelligence and mental capacity.

In the struggle for existence, the animal favored by variation with a larger and more deeply fissured brain than his fellows, is more intelligent, and consequently abler in the struggle for existence. This animal is maintained at the expense of his less intelligent fellows who do not survive. Natural selection operates in the direction of increased size of brain cortex. The gulf by which man is separated from the ape consists in the increase of his cerebral surface.

Psychical variations came to be of more use to animals in the history of the race than physical variations, and were seized upon and maintained. As a result the being possessing them had greater power of adapting himself to the conditions of life. He was enabled by his mental powers to keep, with an unchanged body, in harmony with an ever-changing environment. The being that varied most rapidly

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mentally, and consequently that gained the ascendency, was man. When he migrated he used fire, clothing, and shelter; he invented tools and stratagems, and aided his fellows. He lived by his wits. As man's intelligence increased and as he gained greater control over nature, his body changed less, except such parts as are correlated with intelligence (the cerebral hemispheres), which developed very rapidly.

In addition to the correlation between the size of the cerebral hemispheres and intelligence, there is another, viz.: between size of hemispheres and period of helplessness after birth. The more intelligent an animal, the larger its cerebral cortex, and also the longer the period of infancy.

Now, infancy has a double significance. It comes as the direct result of increased cerebral capacity, and it affords a basis for learning by experience. In the lower creatures with no cerebral development there is but one course which the stimulus can take, and that is the course phylogenetically open to it, the course through the lower centers. This creature, devoid of such higher connections as the cerebrum affords, is a reflex machine—an automaton. Development of the size of the cerebrum means a multiplication of the number of cells in the brain which may become connected with any stimulus. A creature with no secondary brain has no infancy. It reacts the same as the parent to the same stimulus. The infant possessed with a cortex does not make a definite response, but the impulse is diffused throughout the various possible channels afforded by the cortex. This is immediately a disadvantage, and the individual cannot survive unless cared for by the adult parents. If the parents with large brains also possess the parental instinct, their infants will survive, and the helplessness they manifest will be the means of adapting them to their environment.

If the impulse could go in but one direction, and thus give but one element of response, the individual could never learn to discriminate the difference between that and some other possible response. Where the impulse is diffused, and produces consequently various elements of response, the individual possessing them will have a basis for discriminating and, consequently, for valuing them. It is possible only at this stage of development to become a hedonic creature. Pliability lies in

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the fact that any element or group of elements in the whole general response can be discriminated and seized upon by the individual. Training implies that elements from these random movements resulting from the diffusion of the discharge produced by a stimulus, are valued and selected. The interest is concentrated upon the pleasurable element, and more and more of the diffused discharge is led through the selected channel. The person by repeating a process a sufficient number of times becomes as automatic in the response as though controlled entirely by the lower centers.

It is obvious that the greater the number of cortical cells in the brain, the greater number of associations possible, and the greater the range, therefore, of psychical activity. Education and adjustment imply to a very large degree sensori-motor connection. The creature having only one sensori-motor path can have only the very most limited associative power, or power to learn by experience. The greater the number of possible connections the greater the teachableness, but at the same time the longer a period of time it takes also to make complete adjustment.

The lowest vertebrate animal, Amphioxus, has no infancy. The young do whatever the parents do, the only difference being the size. This animal has no cerebrum. It does not care for its young. Neither can it learn by experience. Fishes have very little cerebral brain. They have no perceptible helplessness at birth. In birds the brain develops, infancy extends, and the maternal instinct appears. Most birds are also quite teachable. Dogs, horses, and apes are teachable. The manlike apes of Africa and the Indian Archipelago have advanced beyond the mammalian world. They have greater brain capacity, greater intelligence, also a greater period of helplessness. These tailless apes are helpless for some three months. During this time they are unable to walk, to feed themselves or to grasp things with precision. The human infant has a very much longer period of helplessness than any of the other animals. And when we compare the size of man's brain and his achievements with those of other animals, we have demonstrated to ourselves in an overwhelming manner the above assumed correlations.

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The question, Will the period of human infancy continue to lengthen? is an interesting as well as important one. The answer will also imply whether the size of the cerebral cortex will continue to increase, and whether the capacity for intelligence in the human race will continue to increase; and for this reason the solution is a doubly important and interesting one. If the conclusion reached from present indications is a sound one, the answer is not very encouraging, because it is in each case negative. In an article printed in the last issue of these *Studies* the author has attempted to show that man has about reached his physical and mental limit in evolution. Physical selection became more and more hampered as man became more and more intelligent, and ceased altogether when man gained complete control over nature. Mental selection developed for a long time the size of the brain cortex; but this, too, if it is changing at all—which is doubtful—is not changing rapidly enough to account for man's progress. In proportion as education becomes a general factor in the human race, cerebral selection also becomes less and less potent, and, where there is universal education, ceases entirely.

Present conditions maintain the unfit as well as the fit, both physically and mentally. Physical adaptation is by means of surgery and inoculation, and mental adaptation by means of education. The mediocre and even the mentally poor are, by means of education, adapted to their environment, and thus are enabled, like a normal individual, to marry and to bring up a family. The birth-rate among the lower classes is very great, and their natural increase is considerably greater than that of the upper classes. The lower races have smaller and less deeply folded brains than the higher. They also have shorter infancy. A Maori and even a Negro child matures younger than a white one. The Negro adolescent becomes sluggish and mentally inert. This is the age when the child of the white man becomes most active and pliable. There is also somewhat of a general difference between the children of the two classes (upper and lower) at this age. If it is true that the natural increase of the lower races and classes is greater than that of the higher, then the size of the cerebral cortex will tend to diminish, and also the length of the period of teachableness will decrease.

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Butler[1] distinguishes between physical and spiritual adjustment. Physical adjustment is made after the child can walk alone, feed itself and use its hands. When physical adjustment is thus made, there remains yet to be accomplished the building of harmonious and reciprocal relations with those great acquisitions of the race that constitute civilization; and therefore the lengthening period of infancy simply means that we are spending nearly half of the life of each individual in order to develop in the young some conception of the vast acquirements of the past and some mastery of the conditions of the present. This view is only partially justifiable, because all acquisition involves sensori-motor activity. This acquisition or adaptation among the lower beings, or even among lower races or individuals, to the higher spiritual environment is impossible because of just this lack of pliability.

Civilization implies that the environment is becoming more complicated, that each generation is working at a higher level, and with better tools which our predecessors have handed down. Evolution has been transferred from the organism to the environment, and it is the accumulated structure which persists. This requires in each subsequent generation greater plasticity; but it is probable that the preceding generations have had a reserve, and that only under modern conditions, where there is universal education, is it called into activity.

[1] *Meaning of Education*, p. 13.

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THREE MIDDLE ENGLISH RELIGIOUS LYRICS

By George Coffin Taylor

Attention has not been called, I believe, to the fact that Nos. IX and X of Poems of Manuscript Cambr. DdV. 64, fol. 134–142,[1] taken together, comprise *The Love of Jesus*, from Lambeth MS. 583, pp. 90–102.[2] Aside from differences of dialect, occasional differences of phrase, and differences in the arrangement of material, the *Cambr.* and *Lamb.* poems are the same. Lines 1–136 and 229–284 of *Lamb.* comprise poem No. X of *Cambr.*, while lines 137–228 of *Lamb.* comprise poem No. IX of *Cambr.* Which of the two versions is the source of the other, one cannot say with certainty. Perhaps they are both based on a similar original. The *Cambr.* version is ascribed to Richard Rolle, who lived about 1300–1349. The *Lamb.* version is dated by Furnivall about 1340.[3] It would seem, however, that *Cambr.* is either the source of *Lamb.* or approximates more closely than *Lamb.* the original source, for the following reasons: First, the metre of *Lamb.*, where it differs from that of *Cambr.*, is generally uncertain, and forced as if it were the work of an unskilled versifier. *Cambr.*, on the contrary, is for the most part good metre, such as we should expect from Hampole's pen. Secondly, *Lamb.*, which is written in eight-line stanzas, though uniform in this respect throughout almost the entire poem, presents one irregularity of versification; lines 217–220 constitute a four-line stanza. *Cambr.*, on the contrary, written in long four-line stanzas, is uniform in this respect throughout. It is significant that just at the point above mentioned in *Lamb.*, where the irregularity occurs, lines 217–220, *Lamb.* departs most widely from *Cambr.* Thirdly, the arrangement of material in *Cambr.* is fairly logical, while in *Lamb.* it is confused. The opening stanza of *Cambr.* IX, for example, is, to one familiar with hymns of this type in Middle English, very evidently the conventional beginning of many

[1] C. Horstman, *Library of Early English Writers*, Richard Rolle, Vol. I, pp. 75 ff.

[2] Furnivall in *Hymns to the Virgin and Christ*, E. E. T. S., pp. 22 ff.

[3] *Loc. cit.*, p. 18.

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such poems. In *Lamb.* the stanza corresponding to this is imbedded in the middle of the poem.[1] Lines 69–96 of *Cambr.* X follow naturally the subject-matter preceding. The lines, however, corresponding to these in *Lamb.* there complete the poem, following very unnaturally the subject-matter immediately preceding it. For these reasons, I am inclined to believe that *Lamb.* is based on *Cambr.* Whether the peculiarly confused arrangement of *Lamb.* is due to the fact that the scribe purposely made the change, or made a mistake in copying from leaf to leaf, I am unable to conjecture.

I quote the two versions side by side:

CAMBR. MS.	LAMBETH MS.
IX	Loue is lijf þat lastiþ ay
(I) Hesu god son, lord of mageste,	Þere it is in crist made fest,
Send wil to my hert anly to couayte þe;	Whanne wele ne wo it slake may,
Reue me lykyng of þis land, my lufe þat þou may be;	As writen han men wisest.
Take my hert in til þi hand, sett me in stabylte.	Þe nyȝt it turneþ in-to day,
	Traueile it turneþ in to rest:
	If þou wolt do as y þee say,
	Þou schalt þanne be with þe best.
Ihesu þe mayden son, þat wyth þi blode me boght,	Loue is a þouȝt with greet desijr,
Thyrl my sawule with þi spere, þat mykel luf in men hase wroght.	And also of a fair loouynge;
Me langes, lede me to þi lyght, & festen in þe al my thoght,	Loue y likne in-to a fier
In þi swetnes fyll my hert, my wa make wane till noght.	Þat slakeen may for no þing.
	Loue clensiþ us of oure synne,
	loue oure blis schal bringe,
	Loue þe kingis herte may wynne,
	loue of ioie euere may synge.
Ihesu my god, Ihesu my keyng, forsake noght my desyre,	Þe socour of loue is liftid hie,
My thoght make it to be meke, I hate bath pryde and Ire:	For into heuen it ran;
Þi wil es my zhernyng; of lufe þou kyndel þe fyre.	Me þenkiþ in herte þat it is sliȝe,
Þat I in swet louyng with aungels take my hyre.	Þat makiþ þe peple boþe pale & wan.
	Þe beed of blis it goiþ ful ny,—
	I telle ȝou it as y can,—
	Þerof us þenkiþ þe wey to drie,
	For euere loue coupliþ god to man.
Wounde my hert with-in, & welde it at þi wille:	Loue is hetter þan þe cole
On blysse, þat neuer sal blyn, þou gar me fest mi skylle;	To hem þat of it is fayn & frike,
Þat I þi lufe may wyn, of grace my thoght þou fylle.	Þe flawme of loue, who myȝte it þole,
And made me clene of syn, þat I may come þe tylle.	If it were euermore lijke:
	Loue us heliþ, & makiþ in qwart,
	And liftiþ us up in-to heuene-riche,
	And loue rauishiþ crist in-to oure herte,
	I wot nowhere no loue it is lijke.

[1] The stanza is there printed, however, *Ihesu* instead of *ihesu*.

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Rote it in my hert, þe memor of þi pyne:
In sekenes & in quert þi lufe be euer myne;
My ioy es al of þe: my sawle take it as þine;
My lufe ay waxand be, sa þat it neuer dwyne.

My sang es in syghyng, whil I dwel in þis way;
My lyfe es in langyng, þat byndes me nyght & day,
Til I com til my kyng, þat I won with hym may,
And se his fayre schynyng, & lyfe þat lastes ay.

Langyng es in me lent, for lufe þat I ne kan lete;
My lufe it hase me schent, þat ilk a bale may bete.
Sen þat my hert was brent in Cryste lufe sa swete,
Al wa fra me es went: & we sal neuer mete!

I sytt & syng of lufe-langyng, þat in my hert es bred:
Ihesu my keyng & my ioyng, whyne war I to þe led?
Ful wele I wate in al my state, in ioy I sulde be fed:
Ihesu me bryng til þi wonyng, for blode þat þou hase sched.

Demed he was to hyng, þe faire aungels fode:
Ful sare þai hym swyng, when þat he bunden stode,
His bak was in betyng, & spylt hys bliased blode,
Þe thorn-corond þe keyng, þat nayled was on þe rode.

Whyte was his naked breste, & red his blody syde,
Wan was his faire face, his woundes depe & wyde
Þe iew is wald not wande to pyne hym in þat tyde:
Als streme does of þe strande, his blode gan downe glyde.

Leerne to loue if þou wolt lyue
Whanne þou schalt hens fare;
Al þi þouȝt to him þou ȝeue
Þat may þee kepe from care;
Loke þou þin herte fro him not twynne
Douȝ þou wandre euery where,
So þou may weelde him with-inne,
And loue him hertili euermore.

Ihesu, þat me loue hast lende,
In-to þi loue þou me bringe,
Take to þee al myn entente
Þat þou be to me myn ȝerninge,
And þat synne from me awei were went.
And loue come myn owne coueitynge,
Þat my soule hadde herd & hent
Þe songe of þi sweete louynge.

Þi loue is to us euerelastynge
Fro þat tyme þat we may verrili fele,
Derinne make we euere brennynge,
Þat no þing may uerrili keele.
Mi þouȝt, take it into þin hand,
And stable þou it ilke a dele,
Þat y be no þing hildande
To loue uerrili þe worldis wele.

If y loue ony erþeli þing
Þat paieþ to my wille,
And sette my ioie in foule likinge,
Whanne it may come me tylle.
I may drede at my departynge
Þat it wole be attir & ille,
For alle my welþ is ben wepinge
whanne peyne my soule wolde spille.

Þe ioie þat men heere seen
Is ful likinge vnto þe iȝee;
Þat now is fair, freische, and grene,
And anoon aftir is welkid awey:
Dis is e world, alle men moun seen,
And wole be vnto domysday,
Ful greet traueile, & myche tene;
To flee þat is ful hard in fay.

If þou leue yuel in al þi þouȝt,
And hate þe filthe of synne
And ȝeve to him þat þee dere bouȝt,
Þat he weelde þee with-inne,
Al þi soule þi lord haþ souȝt,
And þerof he wolde not mynne;
Þus schalt þou to blis be brouȝt,
And wonye heyene wiþ-ynne.

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Blynded was his faire ene, his flesch blody for-hette;
His lufsum lyf was layde ful low, & saryful vmbesette.
Dede & lyf began to stryf wheber myght maystre mare,
When aungels brede was dampned to dede to safe oure sauls sare.

Lyf was slayne & rase agayne, in faire-hede may we fare;
And dede es broght til litel or noght, & kasten in endles kare.
On hym þat þe boght, hafe al þi thoght, & lede þe in his lare;
Gyf al þe hert til Crist þe qwert, & lufe hym euermare.

X

(L)uf es lyf þat lastes ay, Þar it in Criste es feste,
For wele ne wa it chaunge may, als wryten has men wyseste.
Þe nyght it tournes in til þe day, þi trauel in tyll reste;
If þou wil luf þus as I say, þou may be wyth þe beste.

Lufe es thoght, wyth grete desyre, of a fayre louyng;
Lufe I lyken til a fyre þat sloken may na thyng;
Lufe vs clenses of oure syn, lufe vs bote sall bryng;
Lufe þe keynges hert may wyn, lufe of ioy may syng.

Þe settel of lufe es lyft hee, for in til heuen it ranne;
Me thynk in erth it es ale, þat makes men pale and wanne.
Þe bede of blysse it gase ful nee, I tel þe as I kanne,
Þof vs thynk þe way de dregh; luf copuls god & manne.

Lufe es hatter þen þe cole, lufe may nane be-swyke;
Þe flawme of lufe wha myght it thole, if it war ay I-lyke?
Luf vs comfortes & mase in qwart, & lyftes tyl heuen-ryke;
Luf rauysches Cryste in tyl owr hert, I wate na lust it lyke.

For-soþe þe kinde of loue is þis,—
Þere it is trusty and trewe,—
To stoonde euere in stabilnes,
And chaunge neuere for no newe.
Þat wiȝt þat þat loue may finde,
Or euere in herte it knewe,
Fro care it turneþ þat kinde:
Such a mirþe fyndiþ to fewe.

For-þi, loue þou as y þee rede;
Crist is trewe loue, as y þe telle;
Wiþ aungilis take þou þi stide;
Þat ioie loke þou not felle.
In erþe hate þou no maner qweed,
But loke þat þi loue may dwelle,
For loue is more strenger þan deed,
Loue is more harder þan helle.

Loue is liȝt, & a birþun fyne;
Loue gladiþ boþe ȝonge and oolde;
Loue is wiþout ony pyne,
As louers han me toolde.
Loue is goostli deli-clouse as wiȝn
Þat makiþ men boþe big & bolde;
To þat loue y schal me so faste tyne,
Þat y in herte it euermore holde.

Loue is þe swettiste þing
Þat heere in erþe men may han;
Loue is goddis owne derlinge;
Loue byndiþ boþe blood & baan.
In loue, þerfore, be oure likinge;
I knowe no betere won;
For me oonli, & my louynge,
Loue makiþ boþe but oon.

But al fleischli loue schal fare
As dooþ þe flouris of may.
And schal be lastande na mare
But as it were an hour of a day;
And sorewen aftir þat ful sare
Hir lust, her pride, & al her play,
Whanne þei aren cast in care,
In-to pyne þat lastiþ ay.

Whanne her bodies in þe fen liggen,
Þanne schulen her soulis be in drede,
And up aȝen as men schulen risen,
And answere for her mys dede.
If þei be seen þan in synne,
And now heere þer liif þei ledde,
Þan schulen þei ligge helle wiþ-inne,
And derkenes haue to mede.

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Lere to luf, if þou wyl lyfe when þou sall bethen fare.
All þi thoght til hym þou gyf, þat may þe kepe fra kare,
Loke þi hert fra hym noght twyn, if þou in wandreth ware,
Sa þou may hym welde & wyn and luf hym euermare.

Ihesu þat me lyfe hase lent, In til þi lufe me bryng,
Take til þe al myne entent, þat þow be my shernyng.
Wa fra me away wat went & comne war my couaytyng,
If þat my sawle had herd & hent þe sang of þi louyng.

Þi lufe es ay lastand, fra þat we may it fele:
Þare-in make me byrnand, þat na thyng gar ti kele.
My thoght take in to þi hand, & stabyl it yik a dele,
Þat I be noght beldand to luf þis worldes wele.

If I lufe any erthly thyng þat payes to my wyll,
& settes my ioy & my lykyng when it may com me tyll,
I mai drede of partyng, þat wyll be hate and yll:
For al my welth es bot wepyng, when pyne mi saule sal spyll.

Þe ioy þat men hase sene, es lyckend tyl þe haye,
Þat now es fayre & grene, and now wytes awaye.
Swylk es þis worlde, I wene, & bees till domes-daye,
All in trauel & tene, fle þat na man it maye.

If þou luf in all þi thoght, and hate þe fylth of syn,
And gyf hym þi sawle þat it boght, þat he þe dwell with-in:
Als Crist þi sawle hase soght & þer-of walde night blyn,
Sa þou sal to blys be broght, & heuen won with-in.

Riche men her hondis schal wrynge,
And her wicked werkes abie
In flawmes of fier bitterli brennynge
Wiþ care and sorewe schamefastli.
If þou wolt loue, þan may þou synge
To þi lord crist in melodie:
Þe loue of him ouercomeþ al þing;
In loue lyue we & die.

Ihesu! god-is sone þou art,
lord of moost hiȝ magiste,
Sende verrili loue in-to myn herte
Oonly to coueite þee!
Reue me likinge of þis world,
Mi loue þat þou may be;
Take myn herte in-to þi ward,
And sette þou me in stabilte!

Ihesu! þou, þe maidens sone,
Þat with þi blood me bouȝte,
Dirle my soule with þi spere anoon,
Þat myche loue in men hast wrouȝt.
Me longiþ þou lede me into þi siȝt,
And fastne þere in þee my þouȝt;
In þi swetnes make myn herte liȝt,
Þat al my woo wexe to nouȝt.

Ihesu, my god & my louell king!
Forsake þou not my desijr;
Mi þouȝt make to be meekinge;
I hate boþe pride & ire.
Þi wil is al my desirynge;
Of loue kyndele þou þe fier,
Þat y with þi sweete louynge
Wiþ aungils take myn hire.

Wounde þou myn herte wiþ-inne,
And weelde me at þi wille;
Of blis þat neuere schal blynne,
Þou fastne me þat y not sille.
Þat y þi loue may wynne,
Of grace my þouȝt þou fille,
And make me cleene of synne
Þat y may come þee tille.

Ihesu! putte in-to myn herte
Þe memorie of þi pyne!
In sijknes, and eek in qwarte,
Þi loue be euere myne!
Mi ioie is al of þee;
My soule, take it as þine;
Mi loue euere wexinge be,
So þat y neuere dwynne.

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Þe kynd of luf es þis, þar it es trayst and trew:
To stand styll in stabylnes, & chaunge it for na new.
Þe lyfe þat lufe myght fynd or euer in hert it knew,
Fra kare it tornes þat kyend, & lendes in myrth & glew.

For now, lufe þow, I rede, Cryste, as I þe tell:
And with aungels take þi stede-þat ioy loke þou noght sell!
In erth þow hate, I rede, all þat þi lufe may fell:
For luf es stalworth as þe dede, luf es hard as hell.

Luf es a lyght byrthen, lufe gladdes song and alde,
Lufe es with-owten pyne, als lofers has me talde;
Lufe es a gastly wynne, þat makes men bygge & balde,
Of lufe sale he na thyng tyne þat hit in hert will halde

Lufe es e swettest thyng þat man in erthe has tane,
Lufe es goddes derlyng, lufe byndes blode & bane.
In lufe be owre lykyng, Ine wate na better wane,
Fore me & my lufyng lufe makes bath be ane.

Bot fleschly lufe sal fare as dose þe flowre in may,
And lastand be na mare þan ane houre of a day,
And sythen syghe ful sare þar lust, þar pryde, þar play,
When þai er casten in kare, til pyne þat lastes ay.

When þair bodys lyse in syn þair sawls mai qwake & drede:
For vp sal ryse al men and answer for þair dede;
If þai be fonden in syn, als now þair lyfe þai lede,
Þai sal sytt hel with-in, & myrknes hafe to mede.

Riche men þair handles sal wryng, & wicked werkes sal by
In flawme of fyre bath knyght & keyng, with sorrow schamfully.
If þou wil lufe, þan may þou syng til Cryst in melody,
Þe lufe of hym ouercoms al thyng, þarto þou traiste trewly.

My loue is euere in sikinge
While y dwelle in þis way;
Mi loue is in þee longynge,
Þat bindiþ me nikt & day
Tille y come vnto my king,
Dere y wone with him may,
And se his fair schynynge
In likt þat lastiþ ay.

Longinge is in me so lent
For loue, þat y ne can lete;
His oue he haþ me now sent
Þat euery bale may bete;
Siþen þat myn herte was brent
In cristis loue so sweete,
Al woo fro me awei is went
And we neuere aken schulen mete.

I sitte and synge of loue longynge
Þat in my brest is now bred.
Ihesu, my king and my ioiynge!
Whi ne were y to þee led?
Ful weel y woot in al my gernynge,
In al ioie, y schulde be fed.
Ihesu! me brynge to þi woniynge,
For þe blood þat þou hast bleed.

Demed he was on a crosse to heng,
Þe fair aungelis foode;
Wiþ scourgis þei gan him sore swing
Whanne þat he bounden stoode;
His brist was bloo in betyng,
Not spilt was his blood;
Þe þorn crowned þat king
Þat doon was on þe roode.

White was his nakid breest,
& reed his bloodi side,
Wan was his face fairest,
Hise woundis depe & wide.
Þhe Iewis wolde not þan reste
To pyne him more in þat tide;
Al he suffride þat was wisest,
His blood to lete doun glide.

Blyndid were hise faire yken,
And al his fleisch bloodi for-bete;
Hise louesum likt at alle men sike [n],
Ful myldeli he out gan lete.

Deed & likt bigunne to striuen
Wheþer myht be maister þere;
Liif was slayn, & roos a-yen;
In-to blis ful fair may we fare.
He þat þee bouht haue al þi þouht,
And lede he it in to his loore;
Seue al þin herte to crist in qwarte,
And so to loue him euermore.

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Sygh & sob, bath day & nyght, for ane sa fayre of hew.
Þar es na thyng my hert mai light, bot lufe, þat es ay new.
Wha sa had hym in his syght, or in his hert hym knew,
His mournyng turned til ioy ful bryght, his sang in til glew.

In myrth he lyfes, nyght & day, þat lufes þat swete chylde:
It es Ihesu, forsoth I say, of all mekest & mylde.
Wreth fra hym walde al a-way, þof he wer neuer sa wylde:
He þat in hert lufed hym, þat day fra euel he wil hym schylde.

Of Ihesu mast lyst me speke, þat al my bale may bete.
Me thynk my hert may al to-breke, when I thynk on þat swete.
In lufe lacyd he hase my thoght, þat I sal neuer for-gete:
Ful dere me thynk he hase me boght, with blodi hende & fete.

For luf my hert es browne to brest, when I þat faire behalde.
Lufe es fair Þare it es fest, þat neuer will be calde.
Lufe ve reues þe nyght rest, in grace it makes us balde;
Of al warkes luf es þe best, als haly men me talde.

Na wonder gyf I syghand be & sithen in sorow be sette:
Ihesu was nayled upon e tre, & al blody for-bette;
To thynk on hym es grete pyte, how tenderly he grette—
Þis hase he sufferde, man, for þe, if þat þou syn wyll lette.

Þare es na tonge in erth may tell of lufe þe swetnesse;
Þat stedfastly in lufe kan dwell, his ioy es endlesse.
God schylde þat he sulde til hell þat lufes & langand es,
Or euer his enmys sulde hym qwell, or make his luf be lesse!

I siȝe, y sobbe, boþe day & nyȝt,
For oon þat is so fair of hue;
Þere is no þing myn herte may liȝt
But his loue þat is so true.
Who so hadde him in his siȝte,
Or in his herte him knewe,
His moornynge schulde turne into ioie briȝt,
His longynge into glewe.

In mirþe lyueþ he nyȝt & day
Þat loue þat sweete childe;
Wra þe wolde from him awey,
Were he neuere so wielde.
It is ihesu, forsoþe to say,
Of alle meekist & myelde;
He þat in herte him loueþ þat day,
From yuel he wole him schielde.

Of ihesu þanne moost list me speke,
Þat may of al my bale be bote;
Me þinkeþ myn herte wole al to-breke
Whanne y þinke on þat soote.
In loue lauȝt he haþ my þouȝt,
Þat y schal neuere for-lete;
Ful dere me þinkeþ he haþ me bouȝt,
Wiþ bloodi heed, hondis, & feete.

For loue myn herte wole to-berste
Whanne y þat fair loue biholde;
Loue is ful fair Þere it is fest,
Þat neuere wole be coolde
Loue us reueþ þe nyȝtis rest;
In grace it makiþ us boolde;
Of alle wekis loue is þe beeste,
As holi men me haþ tolde.

No wondir if y siȝhande be,
And siþen in woo al bi-sett;
Ihesu was nailid upon þe tree;
Ȝhe, al bloody for-beet.
To þinke on him is greet pitee,
To se how tenderli he gret;
Þis haþ he suffride, man, for þee,
If þat þou wolt þi synnes leett.

Þere is no liif in erþe may telle
Of þis loue þe swetnes:
Þat stidefastli in loue can dwelle,
His ioie is euere eendelees.
God schielde þat he schulde to helle,
Þat of loue longinge kan not ceese,
Or euere hise enemyes schulde him qwelle,
Or þat he so his loue schulde lese.

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Ihesu es lufe þat lastes ay: til hym es owre langyng;
Ihesu þe nyght turnes to þe day, þe dawyng in til spryng.
Ihesu, thynk on vs, now & ay: for þe we halde oure keyng;
Ihesu, gyf vs grace, as þou wel may, to luf þe with-owten endyng.

Ihesu is þe loue þat lastiþ ay,
To him is oure longinge.
Ihesu þe nyȝt turneþ to day,
And derknes in-to day spryng.
Ihesu! þinke on us now and ay,
For þee we holde oure kyng!
Ihesu, ȝeue us grace þat weel may,
To louc þe with oute eendynge!—
A-M-E-N.

The most remarkable lines in the poems, *Cambr.* IX, lines 37 and 38, *Lamb.*, lines 209–212, have their origin in the *Meditation of St. Augustine.* They very obviously correspond to the lines edited by Furnivall with the following remarks: [1]

"In the 1866 issue of the stereotyped edition of Mr. Craik's Compendious History of the English Language, v. 1, p. 193, is the following passage quoted from Sir Frederic Madden's Preface to Havelok: 'Between the years 1244 and 1258, we know, was written the versification of part of a meditation of St. Augustine, as proved by the age of the prior who gave the MS. to the Durham Library, MS. Eccl. Dun. A. iii. 12, and Bodl. 42.' On my applying to the Librarian at Durham for further information about this piece of verse, the Rev. W. Greenwell answered: 'It is upon a small piece of vellum, inserted, and forms no part of the original volume. I send you a correct copy.' The Rev. H. O. Coxe, Bodleian Librarian, has also kindly sent me a copy of the Bodleian version, which I print side by side with the Durham one. Mr. Coxe dates the Oxford copy at from 1300 to 1320 A. D.

"MS. Eccl. Dun. A. iii. 12.

"Wyth was his halude brest
and red of blod his syde
Bleye was his fair handled
his wund dop ant wide

And his arms ystreith
hey up-hon e rode
On fif studes on his body
De stremes ran o blode.

"MS. Bodl. 42, fol. 250.

"Wit was his nakede brest
and red of blod his side
Blod was his faire neb
his wnden depe an uide.

Starke waren his armes
Hi-spred opon þe rode
In fif steden in his bodi
Stremes hurne of blode.'

[1] *Polit., Relig., and Love Poems*, E. E. T. S., p. 243.

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EXTINCT GLACIERS OF COLORADO

By JUNIUS HENDERSON

Although it seems quite probable that the ancient glaciers which have so profoundly modified the alpine regions of Colorado were coexistent with the great continental ice-sheet of the Glacial Epoch, which buried the Upper Mississippi Valley beneath a thick mantle of glacial drift, yet it can hardly be said that there is any direct, positive proof of it; and, even if the glaciers were synchronous, they seem certainly not to have been territorially connected. A glance at the geological map will show that Colorado is not within the limits of the continental ice-sheet as indicated by the lateral and terminal moraines, and there is abundant evidence that the mountain glaciers radiating from the alpine regions covered only a comparatively small portion of the state. There is no evidence of general glaciation, the greater part of the state being free from recognizable glacial phenomena. If it should be considered settled that the ancient mountain glaciers of Montana were connected with the continental glacier in point of time and space, it would merely add to the probability, but not actually demonstrate, that the same was true of the southern Rockies, for the glaciated areas of Colorado were isolated, not only from each other, but from the more northern areas, by wide stretches of unglaciated country.

Cross and Howe say: "It is commonly believed by specialists that the recognizable glaciation of the Colorado mountain region belongs to the latest main stage of the Glacial Epoch known as the 'Wisconsin Stage.' Evidence of more ancient stages has been observed in the Wasatch and Uinta Mountains of Utah, and elsewhere, and it is thought that an interval of great erosion preceded the Wisconsin stage."[1]

The conclusion as to the stage is largely a matter of inference, rather than direct evidence, but it is so reasonable as to force itself emphatically upon the attention.

Owing to the fact that mountain glaciers in cirques and valleys

[1] *Silverton Folio*, No. 120, p. 24, Geol. Atlas, U. S. Geol. Sur.

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having precipitous walls not covered thickly with *névé* or ice, and consequently abundantly supplied with rock material, build their moraines rapidly and shrink, extend or change the shapes of their fronts quickly in response to fluctuations in the relation of precipitation to temperature, extreme caution is necessary in deducing successive widely separated periods of glacial extension and recession from the interference and crossing of distinct moraines. However, there is evidence of a much more reliable nature indicating at least two such periods near Leadville,[1] with a suggestion of a third.[2] It is exceedingly probable that as minute an examination in other parts of the state would bring forth further evidence of a trustworthy character, such as difference in material and amount of weathering of morainal matter, and indications of long periods of erosion between superincumbent and superimposed deposits.

A visit long ago to some unglaciated portion of the state led a writer in a responsible magazine to deny the existence of any evidence of the former presence of glaciers in the Rocky Mountain region[3]—an excellent illustration of the danger of generalization from limited knowledge of a region. Another writer, answering the first, was apparently able to point out but little evidence from the great abundance now known to science.[4]

It is true that the plains of the eastern portion of the state, the foothills and the lower portion of the mountain ranges seem wholly devoid of indisputable evidence of the former existence of glaciers, the ice streams having generally extended but little, if any, below what is now the 8,000-foot line, though whether the altitude was the same during the period of their maximum extension may be doubted.

There are beds of boulders in the Denver Basin which have been designated "glacio-natant drift" and "upland drift."[5] The explanation of these deposits suggested by those terms does not seem satisfactory, or, at best, other explanations seem just as satisfactory; so their origin

[1] *Second Annual Rept., U. S. Geol. Sur.*, p. 229; *12th Mon., U. S. Geol. Sur.*, p. 30; *Jour. Geol.*, Vol., XIII (1905), pp. 285–306.

[2] *Jour. Geol.*, Vol. XII (1904), p. 702.

[3] *Am. Nat.*, Vol. VI (February, 1872), pp. 73–75.

[4] *Ibid.* (May, 1872), p. 310.

[5] *Geology of the Denver Basin*, 27th Mon., U. S. Geol. Sur., pp. 265, 266.

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is an open question. In the same basin a very important deposit of fine silt or loess is found.[1] Similar deposits in other parts of the world have been variously ascribed to subaërial, glacial, or glacio-aqueous origin. The Denver Basin loess is apparently continuous with that which extends across Nebraska and Kansas practically to the Missouri, and perhaps with that of Iowa and adjoining states. It overlaps glacial drift in Lancaster County, Nebraska.[2] There is some difficulty in assuming a body of water of sufficient size to furnish a settling reservoir for the detritus brought down by streams from beneath the ancient mountain glaciers or the continental glacier and spread it over such a large territory. Formation by dust blown across the mountains from the arid Great Basin is equally objectionable, as in such case many of the mountain valleys would have caught and held similar deposits. To one familiar from long association with the windstorms of the Great Plains and foothill region, æolian processes seem fully efficient to produce such formations on the largest scale. Every such storm which sweeps down from the mountains carries out to the plains many tons of finely divided materials, to be again picked up by the next storm and borne farther away, and being continually ground finer and finer. This process has been going on for ages, and the aggregate in the course of even a few centuries is of considerable importance; but of much greater moment is the work the winds have been performing for ages, assisted by streams, frost, chemical solution, alternating heat and cold, and other forces, in the disintegration, destruction and redeposition of the Tertiary formations of the plains. Since those formations were first exposed to atmospheric influences there has been time enough for the rocks to be disintegrated, and their component materials to be worked over and over by wind and water, until left in their present condition. The exact origin of the loess may never be definitely known, but surely the solution of the problem is well worth striving for. Whatever may be the ultimate conclusion, it cannot affect the statement that the glaciers of the Colorado Rockies did not extend to the plains, so far as the evidence goes.

[1] *Ibid.*, pp. 41, 258, 278.

[2] *Geology and Underground Waters of the Central Great Plains*, 32d Prof. Paper, U. S. Geol. Sur., p. 138.

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Absence of county lines, towns, government subdivisions, and other useful data from early maps, vagueness in the designation of localities in early reports, and unstable nomenclature of streams and mountains, together with positive contradiction of maps by text in some instances, have made it difficult accurately to locate some glacial areas without a personal visit, which has been impractical. It seems certain, however, that the work of ancient glaciers has been reported in at least twenty-two of the fifty-nine counties of the state, as follows: Archuleta, Boulder, Chaffee, Clear Creek, Conejos, Dolores, Gilpin, Grand, Gunnison, Hinsdale, Lake, La Plata, Larimer, Montezuma, Ouray, Park, Pitkin, Routt, San Juan, San Miguel, Summit, Teller. There are also some remarks in the reports from which glaciation might be inferred in Custer, Fremont, Huerfano and Saguache Counties, and it is, of course, entirely possible that some reports may have been overlooked through faulty indexing and cataloguing of the literature of the subject. The eastern-most area is the Pike's Peak region, near the center of the state from east to west, thus cutting out the entire eastern half of the state. The areas in some of these counties are very limited, in others more extensive; but probably the glaciers did not extend over the whole surface of a single county. These areas aggregate several hundred square miles. In the Leadville region alone a single party has somewhat carefully studied 250 square miles of glaciated territory,[1] and it is probable that in the Arapahoe and Long's Peak region there are at least 500 square miles of glaciation, practically continuous; but the aggregate is small compared with the total area of the state, about 103,925 square miles. It is not at all likely that all of the areas have yet been reported, and certainly few have been exhaustively studied. Probably a careful examination would reveal some evidence of glaciation in the vicinity of all mountains in Colorado which rise above 12,000 feet, and at least one place is reported where a glacier originated at an altitude of 11,000 feet. They generally occupied pre-existing valleys, changing the cross-sections from the V-shape characteristic of rapid stream erosion to the U-shape of glacial valleys, their work being confined to modifying rather than making valleys. Some of them reached a length of twenty miles

[1] *Jour. Geol.*, Vol. XII (1904), p. 698.

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or more, but in the region most familiar to the writer they seldom extended more than ten or twelve miles from the top of the range.

The comparative recency of their retreat is attested by the freshness of their work in the upper courses, the fact that the small residual glaciers and *névés* are still shrinking, and the fact that the streams have deepened their channels but little since the ice disappeared. The subsequent modification, while plainly apparent, is superficial. The sides of mountain moraines are usually quite steep as a result of rapid building, hence are subject to rapid modification by erosion, and the metamorphic rocks constituting most of the mountain heights are easily disintegrated by atmospheric agencies, so that the rounded surfaces are soon broken up and the polish erased, making the glacial work in the lower portions of the valleys look much older than the upper portions, the apparent difference in age being perhaps greater than the real difference.

Lakes of various sizes, both rock basin and morainal, abound in the upper portion of the glacial valleys, those formerly existing in the lower portions having been filled or drained by the various agencies always laboring for the destruction of all lakes.

Roches moutonnées form prominent features of the landscapes and are much fresher in the upper valleys, where the disappearance of the ice has been so recent that vegetation has not yet been able to re-establish itself. Owing to the extreme ease with which gneiss and coarse granite are weathered, polished knobs and scratched boulders are not common. The best examples seen by the writer are in Camp Albion Gulch, northeast of Arapahoe Peak; but why they should be fresher than on the same kind of rocks in the same zone in adjoining gulches has not been satisfactorily explained, unless that glacier has retreated much more recently and rapidly than the others. The lack of morainal matter also suggests rapid retreat. There is no evidence that the polished rocks have been covered so as to prevent weathering.

The discussion of existing glaciers is not within the scope of this paper, and is therefore left to some future paper.

Following is a list of publications bearing upon the present subject, for the benefit of those who desire more detailed information:

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King's Survey of the Fortieth Parallel, Vol. I, pp. 467, 486, Pl. V.
7th, 8th, and 9th Annual Reports, Hayden Survey (1873, 1874, 1875).
Hayden's Geological and Geographical Atlas of Colorado, Sheets No. 12, 13, 15, and 16.
"Pike's Peak Folio," No. 7, *Geological Atlas, U. S. Geol. Sur.*, p. 5.
"Ten Mile District Folio," No. 48, *Geol. Atlas, U. S. Geol. Sur.*, p. 2.
"Telluride Folio," No. 57, *Geol. Atlas, U. S. Geol. Sur.*, pp. 9, 15.
"La Plata Folio." No. 60, *Geol. Atlas, U. S. Geol. Sur.*, p. 6.
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CONTRIBUTIONS TO THE NATURAL HISTORY OF THE ROCKY MOUNTAINS. I

By T. D. A. Cockerell

ARACHNIDA

A RARE SPIDER AT WARD, COLO.

Ortmann, writing on the distribution of crayfishes (*Cambarus*), remarks that a common and widely distributed species will often have distinct but allied species occupying smaller areas about the boundaries of its range. *Steatoda borealis* Hentz, a spider of the family Theridiidæ, is such a widely distributed form; and in our region has been found at Fort Collins and West Cliff, Colo., and in the White Mountains of New Mexico. At Albuquerque, N. M., Mr. Soltau discovered a new species, *S. grandis* Banks, allied to *S. borealis*. This *S. grandis* has since been found in California, where it is the only known *Steatoda;* so it doubtless has a wide range in the Southwest. From Colorado, Thorell long ago described another species, *S. distincta*, collected at Manitou. This has remained very little known, but I was so fortunate as to rediscover it last July at Ward, the specimen having been identified by Mr. N. Banks. As Ward has an altitude of about 9,000 feet, the species is probably characteristic of the mountains.

AN ADDITION TO THE SPIDERS OF NEW MEXICO

Ariadne bicolor, determined by Mr. N. Banks, was collected by Mrs. Cockerell and Miss Mary Cooper at San Geronimo, N. M., a few years ago. This adds a species, genus, and family (Dysderidæ) to the fauna of New Mexico. Since the publication of the list of New Mexico Arachnida,[1] Mr. Banks has described as new two spiders collected by myself: *Lycosa apicata* from Las Vegas and Las Cruces, and *Syspira pallida* from Mesilla Park.

COLEOPTERA

BEETLES NEW TO COLORADO

An admirable list of the beetles of Colorado, by Professor H. F. Wickham, appeared in the *Bulletin of the Laboratories of Natural History* of the Iowa State University, in 1902. Mr. H. C. Fall has kindly identified a few beetles which I have recently collected in Colorado, and some of them appear to be worthy of record. The most interesting is a Carabid, *Bradycellus californicus* Leconte, found at Ward, 9,000 feet. This is a Californian species, quite unexpected in Colorado. Mr. Fall writes concerning the matter: "*B. californicus* and *B. tantillus* cover the country between them. The two are with difficulty separable and are quite likely not distinct. The Ward example is certainly not separable from Californian specimens in my collection."

Oxacis bicolor, collected at Boulder, is new to Colorado, being the fourth species of Œdemeridæ in the list. The genus, which is also new to the list, is southern, and has three species in New Mexico.

[1] Banks, *Proc. Acad. Nat. Sci.*, Phila., 1901.

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Neoclytus approximatus Leconte, is to be recorded from Boulder. The only previous Colorado record was Morrison (Oslar).

Orphilus ater, found at Halfway House, Pike's Peak, is new for Colorado.

Languria læta Leconte, from Boulder, was only known previously in Colorado from near Fort Collins.

Disonycha triangularis Say, was obtained at Windy Point, Pike's Peak, 12,230 feet. This is much higher than the previous records.

COCCIDÆ

THE GENUS TRIONYMUS, BERG, IN COLORADO

Although the Coccidæ have such limited means of locomotion, many of the genera are exceedingly widely distributed. In a number of cases, this can be readily explained by the fact that they are carried from place to place on cultivated plants; but in other instances no such explanation will suffice. The small genus *Trionymus* contains at present four species, one found in France, one in Russia, one in the District of Columbia, and the fourth was discovered last year at Boulder, Colo., by Mrs. Cockerell. It may be that these insects are not all genetically related, but represent "convergent evolution," due to similar modes of life; but if this is the case, we have at present no proof of it. The Colorado species has been described as *T. nanus* Ckll. It is hardly 1½ mm. long, narrow, very pale yellowish, with yellowish secretion. It occurs under rocks in open grassy places. The microscopic measurements (all in μ) are as follows: Antennal joints: (1) 22, (2) 22, (3) 18, (4) 16, (5) 12, (6) 17, (7) 56. Labium: length about 75, breadth about 47. Anterior leg: femur+trochanter, 97; tibia, 50; tarsus (excl. claw), 40.

THE GUTIERREZIA MEALY-BUG AT BOULDER

Gutierrezia is a small perennial composite plant, exceedingly common in New Mexico, and extending northward even to Montana. In New Mexico it was found to be commonly infested by a small mealy-bug (*Pseudococcus gutierreziæ* Ckll.), easily recognized by the conspicuously white linear ovisac. This insect is now found to occur also in Colorado, as I collected specimens this year in Boulder, near the Sanitarium. It must be regarded as one of the distinctly austral elements which so plentifully mingle with the boreal types along the eastern base of the mountains, and which to my mind forbid the extension of the Transition zone so far east in Colorado as Dr. Merriam's map[1] shows. In the nature of things, this question of the limits of the Transition zone must remain largely a matter of opinion; but while the lower front of the mountains is unquestionably Transition, it seems to me that the austral forms approach the flanks of the range in such force as to entitle most of the country east of Boulder to be regarded as veritable Upper Austral. The females of *P. gutierreziæ* collected at Boulder were found to be much infested by a parasitic fungus, which should be further investigated.

A NEW COTTONY SCALE ON ROSE

In August, 1904, Mr. E. Bethel discovered a cottony scale on twigs of wild rose at Coulter, Middle Park, Colo. The female insects are rather dark brown, 2½–2⅔ mm. long, 2¼–2½ broad, with a conspicuous white ovisac. Microscopical examination shows that the antennæ are eight-jointed, and that the species is in many ways similar to *P. amygdali*

[1] *Bull. 10*, Div. of Biological Survey.

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Ckll., which occurs on peach. It is, however, certainly distinct, as the skin of *P. amygdali* is full of large round and oval hyaline spaces, which are not present in the Coulter insect; the latter has numerous small gland orifices, about 5–7 μ in diameter, each containing a small central dot. The antennæ also differ; for instance, in *P. amygdali* the second joint is 40 μ or less in length; in the Coulter insect it is 50. There are also differences in the legs. The rose cottony scale has accordingly been described as *Pulvinaria coulteri*.

HYMENOPTERA

NEW RECORDS OF COLORADO BEES

In the genus *Nomada* the males are often so unlike the females that it is difficult to match them. The male described below very nearly became the cause of a synonym, but fortunately the error was detected.

Nomada (*Xanthidium*) *collinsiana* Ckll.

♂ Length about 10 mm, some slightly more. In my table of Rocky Mountain species, it runs straight to *N. luteopicta*, but that is a much smaller species, and otherwise different. Head and thorax black, coarsely and as densely punctured as is possible, and clothed with rather long fox-red pubescence, the face, however, not being at all concealed by hair; eyes in life olive-green; head rather broad, the vertex strongly convex, clypeus prominent, facial quadrangle broader than long; clypeus except rather broad upper margin, triangular lateral face-marks (ending in a sharp point some distance below the level of antennæ), a narrow line under eye (not going up the cheeks), basal two-thirds of mandibles, and the rather stout scape in front, all bright lemon-yellow; first joint of labial palpi longer than the other three altogether; flagellum stout, black above and bright ferruginous beneath, the joints oblique and very distinct, not denticulate; labrum yellow; thorax entirely black, except that most of the tubercles, and a small spot on anterior part of pleura (not always present) are yellow; tegulæ yellow, with a reddish-hyaline margin and discal spot; wings yellowish, dusky at apex, stigma ferruginous, nervures fuscous; basal nervure going a short distance basad of t. m.; second s. m. higher than broad, receiving the first r. n. about its middle; legs black, yellow, and red; the hind coxæ, trochanters, and femora nearly all black, except a broad, dull reddish stripe, ending in a squarish yellow patch, on hind femora in front; hind tibiæ and tarsi red, the former with a yellow mark at end; anterior and middle femora yellow and red in front, behind black and red, with a yellow apical mark; anterior and middle tibiæ red and yellow, with a black mark behind; abdomen fusiform, dullish with a minutely tessellate surface, very bright lemon-yellow, with the basal half of the first segment (sending a projection backwards in the middle line) and the extreme (mostly overlapped) bases of the other segments, black; broad apical margins of segments 1 to 5 brown-black; apex with some fox-red hairs; apical plate ferruginous with black edges, narrow, and only faintly notched; venter with four extremely broad, entire bright yellow bands, and a yellow apical spot. Third antennal joint very much shorter than fourth.

Var. a. Apical plate of abdomen black, broader, and strongly notched.

Hab.—Boulder, Colo., abundant at flowers of *Ribes cereum*, flying along with males of *Andrena leptanthi* V. & C., which it resembles in the pubescence; April 29, 1905 (W. P. and T. D. A. Cockerell). This was taken for a new species, but the day following my wife took a female, which proved to be *N. collinsiana*, hitherto known only in the ♀ sex. The female, when quite fresh, has the same red hair on the head and thorax as the male.

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The following new locality-records are interesting for various reasons:

Spinoliella zebrata (Cresson). Alamosa, Colo., Aug. 6, 1903 (S. A. Johnson). ♂, ♀. One male was taken "over Spanish peas, in meadow." This species was previously known only from a single female reported vaguely from "Colorado."

Melanostelis pulchra (*Stelis pulchra* Crawford, 1902); variety with dark flagellum and tegulæ. Boulder, Colo., at flowers of a small vinelike *Astragalus*, June 12, 1905 (W. P. Cockerell). New to Colorado; previously known only from Nebraska.

Halictus lerouxii var. *ruborum* Ckll. (new to Colorado), *H. armaticeps* Cresson, and *H. pruinosus* Rob., all females, were taken by my wife at flowers of *Berberis repens* at Boulder, April 6, 1905.

Perdita affinis Cresson, ♀ (a small specimen), was found on a petal of *Argemone intermedia* at Boulder, June 24. It does not normally visit *Argemone*, and presumably its presence there was accidental.

Gnathias lepida (Cresson), ♀, was found May 24, on the campus of the University of Colorado, at flowers of *Drymocallis*. It had been captured on the flower by a grayish Thomisid spider.

Bombomelecta fulvida (Cresson). Boulder, May 17, 1902 (S. A. Johnson); Virginia Dale, June 19, 1901 (Colorado Exper. Station).

Melecta miranda Fox. Denver, June 8, 1901 (S. A. Johnson); Salida, Oct. 8, 1898 (C. P. Gillette); Fort Collins, July 8, 1904, bred from cells of *Anthrophora occidentalis* by S. A. Johnson.

Pseudopanurgus æthiops (Cresson). Glenwood Springs, Sept. 15, 1903 (C. P. Gillette).

Dieunomia xerophila Ckll., ♂. Sterling, at sunflowers (S. A. Johnson). New to Colorado; previously known from New Mexico.

Prosopis basalis Smith, ♂. Steamboat Springs, August 6, 1904, on flowers below town along river, altitude 6,700 feet (S. A. Johnson). At the same time and place Mr. Johnson also took *Megachile manifesta* Cresson.

FLOWERING PLANTS

NEW MEXICO WEEDS

Few persons who have not paid especial attention to the matter realize the extent to which our flora is invaded by aliens. This is especially the case, of course, in towns and cultivated fields; and is best appreciated when one comes to examine land which has been disturbed and yet not occupied by any crop. At Las Vegas, N. M., the campus of the Normal School was thoroughly gone over, the surface being plowed and scraped, and altered to make suitable levels and slopes, so that no sign of the original rather scanty vegetation remained. During the last week of September, 1902, finding that the fallow ground had produced a new and rather varied flora, I collected everything growing there, finding the following species:

(1) Aliens from Europe: *Melilotus alba, Salsola tragus, Chenopodium album viride, Plantago major, Malva rotundifolia, Polygonum rayi, P. persicaria, Chætochloa viridis, Hibiscus trionum*=9 species.

(2) Aliens from the South and Tropics: *Ipomoea hederacea, Panicum colonum, Amaranthus graecizans*=3 species.

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(3) Aliens escaped from cultivation: *Medicago sativa, Pisum sativum, Zea mays, Avena sativa, Hordeum vulgare, Citrullus citrullus*=6 species.

(4) Natives of New Mexico: *Solanum elæagnifolium, S. rostratum, S. triflorum, Chamæsaracha coronopus, Gærtneria tenuifolia, Iva xanthiifolia, Xanthium commune, X. commune wootoni, Verbesina exauriculata, Grindelia inornata, Helianthus annuus, Cosmos parviflorus, Dysodia papposa, Bahia oppositifolia, Salvia lanceolata, Bouteloua* 2 spp., *Amaranthus chlorostachys, Verbena bracteosa brevibracteata, Malvastrum cockerelli, Gaura coccinea, Sphæralcea cuspidata, S. fendleri lobata, Crassina grandiflora, Gutierrezia sarothræ, Leptilon canadense, Eriocarpum spinulosum, Teucrium laciniatum, Ratibida tagetes, Stipa vaseyi*=29 species. Some of these, like the *Xanthium* and the *Leptilon*, may be aliens to the immediate region, which have established themselves so firmly that they cannot be distinguished from natives.

It would probably be worth while for botanists more frequently to put such facts as the above on record; for, although they appear insignificant taken singly, they would, if sufficiently numerous, afford valuable historical materials at a later date. Already it has become in some instances difficult to distinguish aliens from natives, because we lack information concerning past conditions. A list of the weeds growing under such conditions as the above in Las Vegas fifty years ago would be decidedly interesting; and fifty years hence it will be no less interesting to compare the weed-flora of the locality with that now recorded.

For an interesting discussion of plants growing on denuded areas, see Wallace's *Island Life*, 2nd Edn., pp. 513–15.

THE FLORA OF WARD, COLORADO

We are accustomed to think of the flora of our higher mountains as being entirely of a boreal type, but a careful analysis of the genera represented shows that this is not actually the case. In the Andes the fauna and flora of high elevations appear to have been derived from the surrounding lower lands,[1] whereas in the Rocky Mounatins the circumpolar elements are so conspicuous that we are apt to forget the existence of any others. It is nevertheless a fact that southern and peculiarly American types do invade the mountain heights, one conspicuous genus, *Rydbergia*, being even characteristic of the Arctic-Alpine zone, though its allies are found in the species of *Hymenoxys*, a genus extending even to South America, and not known in the Old World.

When recently at Ward (alt. about 9,000 feet), I made a list of all the genera of flowering plants, exclusive of grasses and sedges, that I saw. It is not to be supposed that the list is complete for that locality, but it is sufficiently so to be highly characteristic. Ward is in the upper part of the Canadian zone, and yet an analysis of the flora gives the following results:

(1) Boreal or Circumpolar genera: *Aquilegia* (*A. cærulea*), *Fragaria, Ribes, Dasiphora* (*D. fruticosa*), *Campanula* (*C. rotundifolia*), *Epilobium, Chamænerion, Nuphar* (*N. polysepalum*), *Rumex* (*R. salicifolius*), *Polygonum, Achillea, Pinus, Chenopodium, Artemisia, Senecio, Geranium* (*G. fremontii*), *Carduus, Arctostaphylos* (*A. uva-ursi*), *Rosa* (*R. sayi*), *Juniperus, Salix, Antennaria, Sambucus, Populus* (*P. tremuloides*) *Ranunculus, Bursa* (*B. bursa-pastoris*, no doubt introduced), *Urtica, Potentilla, Taraxacum* (*T. taraxacum*), *Trifolium* (*T. pratense* and *repens*, introduced), *Galium, Anemone, Pulsatilla,*

[1] *Cf.* BATES in the Appendix to Whymper's work on his travels among the Andes of Ecuador.

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Scrophularia, *Rubus* (*R. stigosus*), *Aragallus*, *Allium*, *Erigeron*, *Prunus*, *Astragalus*, *Acer* (*A. glabrum*), *Picea*, *Vaccinium*, *Arenaria*, *Betula*, *Arabis*, *Saxifraga*, *Draba*, *Mertensia*, *Gentiana*, *Solidago*, *Erysimum* (*E. alpestre*), *Thermopsis* (extends to Asia, but not to Europe), *Sedum* (*S. stenopetalum*),[1] *Lupinus* (not typically boreal), *Halerpestes* (extends to Asia and S. America), *Claytonia* (mainly American), *Capnoides*, *Androsace*, *Polygonum* § *Bistorta*, *Elephantella* (*E. groenlandica*), *Pedicularis* (*P. grayi*)=60 genera.

(2) American genera, nearly all, at least, austral types: *Calochortus* (*C. gunnisoni immaculatus;* Pacific Region genus), *Grindelia* (extends to Peru and Chile), *Gaillardia* (*G. aristata;* genus extends to South America), *Gayophytum* (*G. ramosissimum;* genus extends to South America), *Castilleia* (Western and Southwertern), *Rudbeckia* (extends to Mexico), *Gilia* (*G. pinnatifida*), *Penstemon*, *Frasera* (Western), *Eriogonum*, *Chrysopsis*, *Phacelia* (*P. circinata*), *Phacelia* § *Eutoca* (*P. sericea*), *Symphoricarpos*, *Edwinia*, *Drymocallis*, *Ceanothus* (*C. lævigatus*), *Zygadenus* (but genus has one species in Siberia), *Agoseris* (*A. aurantiaca;* genus extends to South America), *Dodecatheon* (but extends to Asia; perhaps should be treated as boreal), *Machæranthera*, *Oreocarya*, *Thelypodium*, *Distegia*= 23 genera.

Distegia, Raf., has been considered part of *Lonicera*, but it is a characteristic endemic American type, apparently of generic value. It consists of the following forms: *D. involucrata* (*Lonicera involucrata* Banks), *D. involucrata serotina* (*L. involucrata v. serotina* Koehne), *D. involucrata humilis* (*L. involucrata humilis* Koehne), *D. flavescens* (*L. flavescens* Dippel), and *D. ledebourii* (*L. ledebourii* Esch.). The range is from New Mexico to Alaska, east to Quebec and west to California.

The few day-flying Lepidoptera noticed at Ward were all of boreal types; namely, *Colias* (*C. eurytheme*, *C. alexandra*, *C. alexandra* var. *alba*), *Pyrameis* (*P. cardui*, an almost cosmopolitan species), *Chrysophanus*, *Lycæna*, *Pieris*, and *Autographa*.

Two small ichneumon-flies collected at Ward were sent to Dr. W. H. Ashmead, who will describe them as new species of the genera *Bathynictis* and *Catastenus*.

[1] The recently published *Sedum subalpinum* Blankinship, is probably identical with *S. stenopetalum rubrolineatum* Ckll., 1891. It is hardly to be considered a distinct species, I think; and I learn from Dr. Britton that he also doubts its validity.

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VOLUME III NUMBER 2

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

MARCH, 1906

Price, 50 Cents

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EDUCATIONAL QUALIFICATIONS OF VOTERS

By John B. Phillips

The old idea that in a land of liberty everyone should have a voice in the conduct of the government is gradually disappearing with the growth of intelligent citizenship. It is beginning to appear that the vital thing in democracy is equality of opportunity, rather than a share in the management of the government. As long as each has the same chance to succeed in life, it is not of great importance whether or not he has also the right to take part in the government by the exercise of the elective franchise.

Anything that tends to swell the floating vote does not augur well for the welfare of the country. It is well known that the immigrants who first get the right to participate in the elections are not familiar with the principles upon which the American theory of government rests. They are therefore obliged to rely upon some person for the information as to how they shall cast their votes. The person that advises them is the ward boss. His business is to control the immigrant vote. Unable to understand the principles of the political parties, these foreign-born must be appealed to in some other way than by eloquence, and this the boss is not slow to perceive. The laborious method of instructing them in American institutions is not resorted to, but other and more direct and effective methods are employed. In this way the purchasable vote is increased.

It is thus clear that by the unrestricted privilege of the franchise we are introducing into our citizenship a large floating vote. Reared under a different political system, and ignorant of our institutions and the policies of our political parties, these voters fall an easy prey to the arts of the unscrupulous politicians in our large cities and so contribute to establish there the conditions that are now the shame of our municipal politics. While it is not true that all the evils of municipal politics are to be laid at the doors of the foreign-born, yet it cannot be

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denied that their presence has been a strong factor in the development of the political boss.

The requirement that all voters be able to read and write English in addition to the usual requirements of residence and citizenship, would tend very strongly in the direction of weakening the power of the boss. Tweed openly declared that he did not care what the New York papers said about him as his constituents could not read English.

Granting the right to vote to every man without regard to his intellectual qualifications is turning over the management of the affairs of the country to inefficient persons. It is true that it is giving each person an equality before the law as far as the right to vote is concerned, but the effect of this management of the government by illiterate and inefficient persons brings about a condition under which it is impossible for each person to have an equal opportunity for success in life.

It was formerly supposed that universal suffrage would mean equal opportunity, but when such suffrage results in the formation of a strong party machine controlled by one powerful boss who is responsible to nobody, it is clear that the opportunities which should be accessible to all are very much curtailed. The governments of certain of the great cities of the United States are good examples of the way in which equal opportunities are taken away from the people by means of a strong party machine built up by the votes of the ignorant, the foreign-born, and the indifferent voters. It is charged that in certain cities the boss must be " squared " with before perfectly legitimate business may be carried on without constant interruption and annoyance by the authorities. In cases of this kind the exercise of universal suffrage has had an effect just the opposite to that of establishing conditions of equality for all the citizens.

In the great cities of the country the foreign-born and children of foreign-born greatly outnumber the native-born of native parents. The following table shows the males of voting age and the percent of native-born of native parents for the eleven greatest cities of the United States:

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MALES OF VOTING AGE IN AMERICAN CITIES

	Aggregate Voting Population	Native-born of Native Parents	Per cent. Native-born of Native Parents
New York	1,700,670	178,900	17.6
Chicago	511,048	103,674	20.2
Philadelphia	386,953	141,741	36.4
Boston	176,068	47,733	27.0
St. Louis	171,798	42,588	24.8
Baltimore	141,271	57,502	40.5
San Francisco	128,985	27,179	21.6
Cleveland	111,522	23,637	21.2
Buffalo	97,938	20,418	20.8
Pittsburgh	96,563	24,719	25.5
Cincinnati	92,799	22,314	24.0

It thus appears that in our two greatest cities the foreign-born and children of foreign-born make up 80 percent of the voters. In the other cities, except Baltimore and Philadelphia, the pure American stock is seen to be as a rule about one-fourth of the voting population. It is in our greatest cities that the power of the political boss has developed on the most amazing scale. It is in the cities that the influence of American ideals is weakest, and one reason for this is apparent. If but twenty per cent of the population is native-born, it is clear that the foreigners and their children exercise four-fifths of the weight in the solution of political questions. This is why the excise question is the most troublesome problem in the city of New York, and also why the tenement house law is not enforced and the sweatshop not abolished.

Aside from the direct effect upon our politics, the requirement that all voters should have the ability to read and write English would undoubtedly tend to hasten the assimilation of the immigrants by our own people. The principal cause of the colonization of the foreign nationalities in the cities is the inability to speak the English language. A person unable to speak the language of the country in which he is obliged to have his domicile is greatly handicapped in his efforts to make a living. He will easily fall a victim to imposture. The great *desideratum* of the immigrant is the ability to speak the English language. It would therefore seem that the best possible program for

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a state which is receiving a large amount of immigration annually would be to encourage as much as possible the learning of the native tongue.

At the present time the most serious problem of immigration that is confronting the United States is the question of getting the immigrants to go into the country or to the remoter cities instead of colonizing in the great Eastern cities and Chicago. There can be but little doubt that the educational requirement of the voters would give a strong impulse to many of these foreigners to acquire the native language, and, having once acquired this, there would not be the same tendency to congregate in the colony which the more ignorant and illiterate of their brethren had established in the city. Other parts of the United States, where their native tongue is not heard, would not repel them, and their assimilation would be comparatively easy.

A great advantage in favor of the enactment of a law requiring voters to be able to read and write the English language is the fact that such a law would require no administrative machinery to put it into execution. It would be a self-executory law, just as the other election laws are at the present time. Each political party sees to it that all voters of the opposite party comply with the statutes or they are not allowed to vote.

A number of the American states require certain educational qualifications of their voters. Following is the list, with a brief summary of the constitutional provisions.

ALABAMA:

Must read and write constitution in English language.

Following classes exempt:

(*a*) Persons physically unable to read and write;

(*b*) Owners or husbands of owners of 40 acres of land in state;

(*c*) Owners of real estate assessed at $300;

(*d*) Owners of personal estate assessed at $300, on which taxes have been paid for preceding year.

Constitution of 1901, Art. 8, §181.

CALIFORNIA:

Must read constitution in English and write name.

Following classes exempt:

(*a*) Voters in 1894;

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(*b*) Persons physically unable to read and write;
(*c*) Persons 60 years of age in 1894.
Amendment to constitution, Art. 2, §1. Adopted 1894.

CONNECTICUT:
Must read constitution or statutes.
Amendment to constitution. Adopted 1855.
Amendments, Art. 11.
Must read constitution or statutes in English language.
Amendment to constitution. Adopted 1897.
Amendments, Art. 29.

DELAWARE:
Must read constitution in English language and write name. Persons physically unable to read and write exempt.
Constitution of 1897, Art. 5, § 2.

LOUISIANA:
Must write and date application for registration as an elector in presence of registration officer. Following classes exempt:
(*a*) Persons owning property in state assessed at $300 on which, if personalty, the taxes shall have been paid;
(*b*) Foreigners naturalized before January 1, 1908, if they have resided in state five years and registered before January 1, 1908;
(*c*) Voters January 1, 1867;
(*d*) Sons and grandsons of such voters;
(*e*) Persons physically unable to read and write.
Constitution of 1898, Art. 197, §§ 3, 4, 5.

MAINE:
Must read constitution in English language and write name.
Following classes exempt:
(*a*) Persons physically unable to read and write;
(*b*) Voters in 1893;
(*c*) Persons 60 years of age in 1893.
Amendments to constitution, No. 29. Adopted 1892, effective 1893.

MASSACHUSETTS:
Must read constitution in English language and write name. Following classes exempt:
(*a*) Persons physically unable to read and write;
(*b*) Voters in 1857;
(*c*) Persons 60 years of age in 1857.
Amendments to constitution, Art. 20. Adopted 1857.

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MISSISSIPPI:

Must read constitution or understand same when read to him, or give reasonable interpretation thereof.

Constitution of 1890, Art. 12, § 244.

NEW HAMPSHIRE:

Must read constitution in English language. Following classes exempt:

(*a*) Persons physically unable to read;

(*b*) Voters in 1903;

(*c*) Persons 60 years of age January 1, 1904.

Amendment to Article II of Bill of Rights of constitution. Adopted 1903.

NORTH CAROLINA:

Must read and write constitution in English language. Following classes exempt:

(*a*) Voters under the law of any state where residing prior to or on January 1, 1867;

(*b*) Lineal descendants of such voters, provided they register before December 1, 1908.

Amendment to constitution, Art. 6. Adopted 1901, effective 1902.

SOUTH CAROLINA:

Must read and write constitution. Does not apply to persons owning property in state assessed at $300 who have paid taxes of previous year.

Constitution of 1895, Art. 2, § 4.

VIRGINIA:

Must read constitution and give reasonable explanation. If unable to read must understand and explain constitution when read to him. Following classes exempt:

(*a*) Soldiers who have served in war in army or navy of United States or Confederate States or of any one of United States or Confederate States;

(*b*) Sons of such soldiers;

(*c*) Owners of property on which during preceding year state taxes of least one dollar have been paid.

Constitution of 1902, Art. 2, § 19.

WASHINGTON:

Must read and speak English language. Does not apply to voters in 1896.

Amendment to constitution, Art. 6, § 1. Adopted 1896.

WYOMING:

Must read constitution.

Following classes exempt:

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(*a*) Persons physically unable to read;
(*b*) Voters in 1889.
Constitution of 1889, Art. 6, § 9.

A proposed constitutional amendment concerning the suffrage was rejected in Maryland November 7, 1905. It prescribed the following qualifications for voters:

MARYLAND:
Must read constitution or give reasonable explanation, or understand same when read to him and give reasonable explanation. Following classes exempt:
(*a*) Voters January 1, 1869;
(*b*) Lineal male descendants of such voters 21 years of age in 1906.
Laws of Maryland, 1904, Chapter 96.

The constitution of North Dakota says that the legislature shall require an educational qualification of voters, but as yet the legislature has not seen fit to comply with this provision of the constitution.

In the above requirements, the curious proviso which allows the suffrage without restriction to the lineal male descendants of persons qualified to vote during the years immediately following the Civil War is popularly known as the "grandfather clause." It prevails in Louisiana, North Carolina and Virginia. It is calculated to exempt the white voters from educational and other restrictions which effectively bar the negroes.

From the above compilation it appears that real educational qualifications for voters exist only in Delaware, Massachusetts, Maine, New Hampshire, Connecticut, California, Washington and Wyoming. In Delaware, Connecticut, and Massachusetts, practically every voter must read English. In the other states having educational qualifications, voters at the time the requirement was adopted have been exempted from its provisions. This was the case with voters in California, Maine, New Hampshire and Wyoming in 1894, 1893, 1904 and 1889 respectively. Massachusetts also exempted voters in 1857, the year the amendment was adopted, but few of such voters are now living.

The ability to read English as a qualification for voters is a recent development in United States constitutional law. Notwithstanding

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its origin in Massachusetts in 1857, its spread to other states has been almost wholly within the last two decades. The advance in the educational system and the menace of immigration make both possible and desirable the extension of this educational requirement to the voters of the other states.

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SHAKESPEARE AND PSYCHOGNOSIS

ESSAY I. MINOR CHARACTERS OF "THE TEMPEST"

By Melanchthon F. Libby

Introduction

The following essays are intended as a humble contribution, not to literary criticism, but to what may be called *concrete ethics*. Psychology, as has been pointed out by Professor Dessoir, has very little to tell us about human nature. Plutarch, Montaigne and Franklin have insight into human motive and character, but it is idle to call them psychologists. Bismarck, a consummate judge of men, or rather of certain kinds of men, may have been unable to pass a college examination in psychology. Let us call this insight into human nature *psychognosis*, as Professor Dessoir has suggested, and let us keep the word *psychology* for the designation of that special discipline which claims it. The names *characterology* and *ethology* have been used in the same sense as that in which we use psychognosis.

John Stuart Mill thinks that ethics can not become an exact science until we can estimate the moral or social reactions of individual men to given stimuli. In other words, we must be able to tell what any given man will do in any given situation, just as we tell what mercury will do on a hot day or a cold day. This correct estimate of a scientific ethics has proved pedantic and depressing. Ribot and others have attempted to classify human nature by tests in psychological laboratories.

Charlatans have attempted for money to advise parents regarding vocations for children. The more exact in appearance their methods have been, the less substantial truth they have possessed. A pretence of mathematically scientific method in estimating character is either ignorant or fraudulent in our present knowledge of physiology and neurology. Yet the history of civilization reveals a great thirst for this kind of knowledge. Astrology, palmistry, phrenology, physiognomy,

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are only a few of the pseudo-sciences of human nature. The theory of humors in medicine, and even the pretentious utterances of novelists like Meredith and Crawford concerning human motive, are attempts to satisfy this craving without paying the price of such knowledge in scientific research. Child-study and the study of adolescence are crude beginnings of a real science of human nature.

Meanwhile, many generations must elapse before we can look for much in this direction that will satisfy the methodology of serious men of science.

The purpose of the present essays is to present a classification of human types drawn from an inductive reading of Shakespeare. I do not think that any one has employed this method at all thoroughly heretofore. There are great numbers of brilliant studies of the characters in Shakespeare, to all of which I am indebted in this work. But they are all subjective in their selection of the aspects of character to be treated; and none of them reaches the point of considering the significance of the minor characters. Anyone familiar with this field must know that the minor characters of Shakespeare have scarcely been considered by the great critics. Yet I hope to show that a careful appreciation of these foils and background figures gives valuable results in indicating the author's meaning in larger matters. Then, again, in Psychognosis, we must not only study a few striking types of character, but also the typical situations in which men find themselves in the world of real experience.

I offer no apology for the tediousness of my method, nor do I claim that it is free from subjective errors. It is an attempt, not indeed at a science of literature and character, but at some slight departure from the grossest subjectivity.

I have endeavored to bring together all the deeds and utterances of each character in the play, and to stand aside as far as possible while these collected facts gave a general resultant. This self-effacement is, of course, impossible. And therefore I shall be content with the judgment of the judicious. But though I may ignore some speeches too much, or emphasize some too much, that is inevitable. I have at

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least *tried* to be objective, and I believe the method will prevail. By its use a great body of valuable knowledge could be extracted from writers like Balzac and Molière, which would go far to furnish content to the bald abstractions of a worn-out theoretical ethics, and to make the homilies of lecturers on "practical" ethics broader and more helpful.

But Shakespeare's facts about human nature are realities to the psychologist, because of the three hundred years' endorsation of all the thinking races, and in this sense his specimens are as valid as those of the botanist or the lithologist. We may accordingly study his book in the confidence that what we can say of it truthfully will be received as a real contribution to Psychognosis.

The results of this study of the minor characters have proved such as to require me to offer a new reading of the whole play, which will appear in later essays. The results for Psychognosis in general will be considered in the last essay, and those not interested in the inductive method nor in the meaning of *The Tempest* will do well to read that essay only.[1]

In conclusion let me say that Shakespeare, in the Tempest, has left the world *some thirteen types of human character*, and *some thirty types of human situation*, which he manifestly selects as the most clearly distinguishable and important to the student of his kind. And it is not at all improbable that this group of types is the most important chart of the conduct of life that we possess. In my last paper *I shall tabulate these types.*

Gonzalo, a Type of Altruism

The five acts are divided into nine scenes. Gonzalo appears in four of these, the first, third, seventh, and ninth. His first speech is "Nay, good, be patient," addressed to the boatswain, who has been ordering the Duke and the King below. His first speech is a gentle remonstrance against the seaman's speech. His second speech again recommends respect for the nobles; but it, too, is kindly and sympathetic. After the boatswain's exit, Gonzalo makes a longer speech showing

[1] My study of *The Tempest* has yielded only one definite *scholium* which I consider worth offering: Act II, Sc. i., vss., 295, 296.

'And how does your content
Tender your own good fortune?

This is like Macbeth's question to his hired assassins.

It means: How does your patience present your fortune to you? Are you so patient as to think yourself fortunate in your underling situation? Like all Antonio's speeches it is a sneer. Daniel's alteration of the folio shows no regard for the subtle style of this character.

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humor, courage, and yet a clear appreciation of the peril in which the ship stood. After the re-entrances of the boatswain and of the nobles, Gonzalo composes a quarrelsome dialogue by a few words; Antonio and the boatswain are softened by his mild, jocular humor.

Gonzalo, when the fate of the ship appears imminent, recommends that all join the King at prayers; but before going he makes two more speeches, both showing humor and remarkable calmness of spirit. One may generalize these simple facts into the more comprehensive fact, that in a time of great peril, which shook the souls of some of the characters, Gonzalo appeared cool, kindly, sympathetic, unselfish and humorous; and that in spite of a clear grasp of the terror of the situation, he preserved, without noticeable effort, an admirable magnanimity, serenity, and composure of soul, suggesting great inward resources of some kind, with which to face circumstances trying to the bravest of men.

In the first scene of Act II Gonzalo appears again. He begins the dialogue by a speech of nine lines, in which he endeavors to make the best of things. He offers commonplace consolations, which are badly taken by the others, yet he persists in talking, and in a sense achieves his kindly purpose, inasmuch as he forces his companions to talk. He is mercilessly chaffed by Antonio and Sebastian, weakly supported by Adrian and snubbed by the King. After enduring this with unshaken good humor, and some wit in retort, for a while, he makes a sketch of an ideal commonwealth which he would like to establish on the island. This commonwealth shows his great good-will toward men and his love of purity and innocence, but is illogical and impracticable, and represents aspirations rather than serious thoughts, as Gonzalo soon admits by his joining in the ridicule of it. Still, though he calls it merry fooling, it does show that he had dreams or ideals on the subject of social well-being, and in a very humane and benevolent way. Under the influence of solemn music played by Ariel he quickly falls asleep. Immediately ensues the conscienceless conspiracy of Antonio and Sebastian involving the life of Gonzalo as well as of the King. It is in Gonzalo's ear that Ariel sings his summons to watchfulness, and the old Minister awakes, thinking only of his Master. He is not deceived by the story of the conspirators but confines his criticism to the somewhat wry expression, "Heavens keep him (Ferdinand) from these beasts." His concluding words, "For he is, sure, i' the island," are a mixture of prophetic faith and kindly optimism.

The facts of this scene extend our knowledge of Gonzalo. He is not only serene, kindly, courageous, humorous, but broadly benevolent, self-controlled, and devotedly trustworthy. He is conscious of his merry fooling, and talks garrulously only to serve some kind purpose. His intellectual humility is free from meanness or envy, and he accepts his position with a genuine belief that simple faithfulness cannot be despised. That he is not despised is evinced by the fact that he is hated by the conspirators.

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Gonzalo reappears, after a long interval, in the third scene of Act III. He is still with Alonso. Being an old man, he is rather used up by the fatigues of the way. From the search for Ferdinand he rests, not because he would, but because he needs must. The conspirators, seeing Gonzalo and Alonso oppressed with travel, renew their plotting. The music introductory to the magic banquet pleases Gonzalo. Of the strange shapes bringing in the banquet he says, "Their manners are more gentle-kind than of our human generation you shall find many, nay, almost any,"[1] and he fears the Neapolitans would be skeptical if he were to tell them of this adventure. Prospero here speaks of Gonzalo as "honest Lord," which agrees with what he had reported of him to Miranda (in Act I, scene 2) where he had called him "A noble Neapolitan," who, out of his charity had given them garments, and out of his gentleness saved his books for the banished Duke[2]. While the others wonder at the magic table Gonzalo accepts it as if it were quite natural. After the terrible arraignment of the "three men of sin," Gonzalo is very serious; yet he beseeches those who can to follow the three and hinder them from desperate acts. This scene shows Gonzalo's facility in accepting the supernatural as not antecedently incredible, besides confirming former notions of his character.

He appears in the last scene of the play, accompanying Alonso. He is one of those who stand charmed within the circle which Prospero had made. But he is addressed by Prospero in the following terms:

"Holy Gonzalo, honourable man,
Mine eyes, even sociable to the show of thine,
Fall fellowly drops;"

and shortly after, in terms really remarkable,

"O good Gonzalo!
My true preserver, and a loyal sir
To him thou followest, I will pay thy graces
Home, both in word and deed."

Gonzalo says little during this long scene. After the exit of Ariel he expresses a wish that "Some heavenly power guide us out of this fearful country." When Prospero addresses him again, it is in words that Prospero could use of no common man. —

"First, noble friend,
Let me embrace thine age, whose honours cannot
Be measured or confined."

To this great praise Gonzalo replies with customary equanimity, but professes himself puzzled. After a long interval he says,

"I have inly wept,
Or should have spoke ere this."

[1] C. the idealism of *In Memoriam*. [2] Cf. the service of the church to philosophy.

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He is moved that the work of mediation, forgiveness and charity, which had so long devolved upon himself, is so ably borne by another. He is moved by the joy of the lovers: "Look down, you gods, and on this couple drop a blessed crown, for it is you that have chalked forth the way which brought us hither." He points out in a longer speech how all their actions, even the worst, have worked together toward a good conclusion, and especially he rejoices that their experiences have given them self-knowledge, a quality in which he professes himself to have been deficient along with the others. His last words, in response to a good wish uttered by Alonzo, are:

"Be it so: Amen!"

In this last scene the immense authority of Prospero confirms the impressions already received of the character of Gonzalo. Prospero is actuated by personal gratitude; but his firm utterances are not the exaggerations of sentiment, and a closer observation of his praises show that he ascribes no powers to Gonzalo which have not been clearly displayed by the counsellor's career.

Gonzalo is to be judged by his actions, his utterances, and his reputation among his associates. In the first scene, he appears cool and self-possessed in a moment of the utmost peril, where action is impossible. He shows great fortitude, the virtue of a situation of that nature. In the third scene he exerts himself to cheer and revive the spirits of his comrades. It is true he falls asleep in innocent trustfulness though his master is in peril, yet it cannot be said that his sleeping was in the circumstances blameworthy, nor out of harmony with the strictest sense of duty to the King. It may, however, be said that a more suspicious and vigilant counsellor would have taken greater precautions to protect the King from such a friend as Antonio. In the latter part of this scene Gonzalo acts promptly and wisely.

In the seventh scene we learn that he has kept up with the younger nobles in their search "through forthrights and meanders," and that he is fatigued by his exertions for Alonso. After the magic banquet and the searching exhortation of Ariel, Gonzalo acts promptly and kindly in despatching the younger followers of the King to preserve him.

In the ninth scene no action is called for on the part of Gonzalo, and he bears himself with quiet and respectful attention in the presence of a greater and equally benevolent man. The striking common quality of the actions of Gonzalo is that they result from a hearty acceptance of charitable duty as the rule of life: he does all he can to make others better and happier because unselfish devotion is his nature.

His utterances in the four scenes agree with his actions: they are uniformly gentle and moderate, long-suffering without meanness, good without cant, humble without hypocrisy. His patience is boundless, and hence he recommends patience with sincere faith in its transcendent benefits. When the others are in trouble he thinks only of them and not of himself. When forgiveness and joy crown the

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tale Gonzalo is a deep rejoicer. Not one word of his suggests that he ever considers his own troubles or pleasures. His words are not only gentle, they are reverent and inspired with awe for the unseen, faith in the future, deep respect for whatever is of good report. Once he lets us see that contemporary manners are not gentle-kind, yet he would soften them by example rather than precept.

Adrian is his friend. Sebastian and Antonio hate him past reason. They really have no charge against him except garrulity; yet they would kill him that "Sir Prudence" should not afterwards upbraid their course. Alonso accepts his services with dignified courtesy, occasionally showing a slight impatience of his tediousness. Ariel sings to him as he sleeps, and wakes him to renewed vigilance. Miranda says, on hearing how he had assisted her father in the earlier tempest and preserved the learned works: "Would I might but ever see that man!" Prospero speaks of him repeatedly, and always in words of the most sterling respect and affection. What greater praise can Prospero give than that which he solemnly utters in the significant words, "My true preserver!"

To draw the facts thus accumulated together into a statement true of them all is not difficult. Gonzalo is not a complex character; the clearness of the type together with the absence of self-assertiveness may have made Gonzalo seem of small consequence in the plot. But the evidence of Prospero as to his positive worth is conclusive. Gonzalo is an unselfish man. He is a living concrete example of the hearty acceptance of the golden rule of living with ideal kindness and forbearance in a selfish world. He does not unite a powerful head with his excellent heart, but he is on this account only a clearer and simpler example of one of the two great factors in human relations — unselfishness. If the common estimate of the critics regarding Gonzalo seems to agree rather with that of Antonio than with that of Prospero, the presumption is that their estimate is not Shakespearean and that it has not been arrived at by careful induction but rather by attaching undue importance to the chaff of the villains in the third scene. Gonzalo's quiet, conservative efficiency is a cause of Prospero's learning, and hence of Prospero's magic power. Gonzalo is the type of all that is meant by pure unselfishness in human society.[1]

Antonio, a Type of Intellectual Egoism

Antonio appears in the same scenes as Gonzalo. His first words are "Where is the Master, boson?" — a repetition of the King's question; but Antonio does not tell the boatswain to have care, or to play the man. His second speech is, "Hang, cur, hang! You whoreson, insolent noisemaker, we are less afraid to be drowned than thou art." Later he says, "We are merely cheated of our lives by drunkards." But in fact it appears that the sailors used skill and that no blame attached to them. "This wide-chapped rascal — would thou might'st lie drowning the washing

[1] It seems to me that Moulton's fine study of the *Tempest* loses the quest mainly through ignoring the unobtrusive greatness of this talkative old man.

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of ten tides!" is his wish for the sailor. Finally, at the catastrophe, he suggests, " Let's all sink with the King!" The impression received from observing the facts about Antonio in this scene is that he is shrewd enough to see that the sailors will do all they can to save themselves, whatever they may think of the fate of the nobles; that he does not interfere with them or abuse them until he sees that their efforts are unavailing; and that his feeling in peril shows as anger and pride, rather than open fear. He clings to class distinctions, though perceiving that the imminence of death had practically abolished them. He takes a selfish view of the disaster when he says that they, meaning himself and his friends, are cheated of their lives by drunkards, inasmuch as the sailors worked with skill and energy for the common good.

In the third scene, Antonio's first speech is, " The visitor will not give him o'er so." This is a sneer, both at Gonzalo and at philanthropists in general. His next speech is " Fie, what a spendthrift is he of his tongue!" This sneer implies, not that Antonio condemns the free use of words by Gonzalo, but that Gonzalo talks for nothing. Endless volubility for a selfish purpose is clever, but Gonzalo has no purpose in his talk, according to the opinion of Antonio. When Adrian says the island is of a subtle, tender and delicate temperance, meaning climate, Antonio retorts that " Temperance was a delicate wench." There is a good deal of shrewd sense in his criticism of the well-meant consolations of Gonzalo and Adrian. He protests manfully against the slur cast upon Dido. But every word is a sneer, whether true or frivolous. He and Sebastian riddle Gonzalo's fancy commonwealth with most practical objections; one feels that they pronounce authoritatively upon the impossibility of an ideal commonwealth without new provisions against the evils arising from idleness. In this purposeless skirmish of wits Sebastian is more aggressive than Antonio, who says but little, and that mostly in echo of his friend. It is not until the others are asleep that Antonio displays his true ability. He suggests the plot to Sebastian with flattery, and rouses his ambition with promises; he grows animated, eloquent even; politic, insinuating, adroit, he pours his spirits into the ear of Sebastian. Boldness, acuteness, conscienceless logic are mingled with sarcastic humor, scorn, and a splendid but evil resoluteness. He does not spare words where he has a purpose to effect. Prospero sends Ariel to thwart their project. When they are thwarted Sebastian is the bolder, and Antonio's excuses are a weak and even ridiculous echo.

In this scene Antonio appears as lost to all sense of decency and humanity. He is ambitious, selfish, cunning, dangerously clever. His vigilance, energy, adroitness, animated eloquence, sarcastic wit, are admirable; and, better directed, might be great. Less bold in action than Sebastian, he is far bolder in designing and conspiracy.

In Act III, scene 3, he reappears, and our observation of his vigilance and persistence is confirmed by his first two speeches. Whatever his amazement on seeing

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the magic banquet and the shapes, he cannot doubt the evidence of his senses and accepts them as facts quite as fully as Gonzalo. Alonso is profoundly moved by the exhortation of Ariel, but Sebastian's aggressive boldness enables him to say:

"But one fiend at a time,
I'll fight their legions o'er."

Antonio adds, "I'll be thy second." He is the cleverest and worst of the "three men of sin."

In the ninth scene Antonio is with the others in the magic circle. From his entrance to the end he speaks only once, when roused to something of his old sarcastic humor he answers the question of Sebastian regarding the purchasability of the monster Caliban and his friends,

"Very like; one of them
Is a plain fish, and, no doubt, marketable." [1]

In Scene 2 of Act 1 Prospero had given Miranda a long account of the manner in which Antonio had robbed him of his birthright. He says that Antonio used foul play, that he was perfidious, that he treated his brother's simple faith as simplicity and violated the trust reposed in him, that his selfish ambition grew till he believed himself rightful Duke, and that he banished father and daughter with treachery and cruelty. (This was the occasion upon which Gonzalo had done all that his position allowed to save the rightful Duke..)

In the ninth scene Prospero confronts Antonio,

"Flesh and blood,
You, brother mine, that entertained ambition,
Expelled remorse and nature. . .
I do forgive thee;
Unnatural though thou art!"

Later, when he has doffed his magic robe, as rightful Duke of Milan, he says, —

"For you, most wicked sir, whom to call brother
Would even infect my mouth. I do forgive
Thy rankest fault; all of them; and require
My dukedom of thee, which, perforce, I know,
Thou must restore." [2]

In this scene we see the moral prostration of Antonio, who has no single word of defence or palliation, nor even the rude ignorance of Sebastian to give him courage.

The chief actions recorded of Antonio are his usurpation and his conspiracy against the lives of Alonso and Gonzalo. His words are marked by insolence, sneering, flattery, duplicity, craft, and shrewd wit. But his actions and speeches show vigilance, energy, and adroitness, and a clear conception of the value of facts

[1] Cf. Renan's *Caliban*, where the monster stands for the venal rabble.

[2] In his magic robe Prospero is purely philosophic in judgment. When without it, he takes his role in a less detached spirit. This remark applies to other scenes as well.

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and physical force. His friend and companion is Sebastian. He is morally guilty of the murder of Alonso and Gonzalo, and even Prospero and Miranda were spared merely from selfish policy. He is incapable of repentance or any generous sentiment. Prospero declares him to be an unnatural character. Hence he has the contempt of Prospero as a fellow man, whose complete self-knowledge, however, enables him to forgive his enemy, through a philosophic comprehension of causes.

The character of Antonio appears in the light of facts to be clear and simple. Not one word or action is unselfish, no scruple suggested by the sense of a common humanity softens his hard purposes. Friendship, brotherhood, loyalty, honor, law, self-respect, are bonds long since eaten through by ambition. The true human instinct is a vital union of selfishness and unselfishness. Antonio is the type of reason separated from human sympathy, of the reason that has no reason because it is not fused with sympathy. Antonio embodies, like a figure in a new mythology, the character of the rationally selfish. He is less a soldier than a schemer, and hence we may conclude by saying that he is an intellectual egoist.

He is a living embodiment of the second great social force — selfishness. Far superior to Iago in purpose and ambition, he is equally a villain. Far inferior to Richard III in courage, he is less capable of remorse.

Looking at Gonzalo and Antonio, one wonders whether they were not, as types of the extreme forces by which society moves forward, the greatest achievements of their creator. It may appear that all former portrayals of devotion and villainy tended toward the separation and clarification of these two pure types, marking as they do the extremest departures from the middle line of human instinct.

These characters are contrasted in a symmetrical manner rather unusual in great literature. They are contrasted in their treatment of Prospero and Miranda at the time of the banishment; in their bearing during the tempest; in their interview in the third scene where the contrast culminates in the murderous attack of Antonio. In the seventh scene the weakness of Gonzalo is contrasted with the energy of Antonio. But the great and authoritative contrast is found in the pictures of the two offered by Prospero in the final scene; where language is strained to accentuate this antithesis.

It may be said that all degrees of goodness and badness, as far as these term denote unselfishness and selfishness, lie between Gonzalo and Antonio; and yet it would seem at a superficial glance that power belongs rather to Antonio.

Sebastian: The Egoism of Mere Force

Sebastian appears in company with Antonio. His first speech in the shipwreck scene, is —

"A pox o' your throat, you bawling, blasphemous, incharitable, dog."

As the catastrophe approaches, he says, "I am out of patience." When Antonio

[1] Tout comprendre, c'est tout pardonner.

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says "Let's all sink wi' the King," Sebastian replies, "Let's take leave of him." There seems to be a certain dignity in these two speeches, both men desiring to die in a manner becoming to their rank.

In the first half of the third scene Sebastian regularly takes the lead in bantering Gonzalo and Adrian. He addresses his wit chiefly to Antonio, who rather indifferently echoes him. Concerning the marriage of his niece Claribel, he is grossly sarcastic. "'Twas a sweet marriage, and we propser well in our return." But when Antonio takes a somewhat analogous interest in the historic sacrifice of the affections of Dido, Sebastian replies, "Good Lord, how you take it!"

To his royal brother he is equally harsh. He reproaches him bitterly for bestowing Claribel upon a barbarian. Reproached by Gonzalo, he merely growls "very well." He is quick in debate, and exposes the inconsistency of Gonzalo's ideal commonwealth. Yet in spite of his roughness and bluntness he is not altogether bad and cold-blooded. His words to the drowsy King sound fraternal and sincere:

> "Please you, sir,
> Do not omit the heavy offer of it:
> It seldom visits sorrow, when it doth
> It is a comforter."

It is a bold, impartial stroke of characterization to ascribe this speech to Sebastian, for it is a matter of observation that excessive aggressiveness is occasionally touched by womanly tenderness, in a moment of weakness.

After Sebastian has come to understand the evil suggestions of Antonio he says:

> "Well; I am standing water."

He accuses himself of hereditary sloth; meaning evidently intellectual sloth. He shows no initiative in intrigue. He is neither good nor bad. In practical affairs he is energetic, and in banter or debate very wide-awake.

When Antonio asks him how his slothful content paints his good fortune, he awakes to the sense of his subordinate position, and the ambitious spirit of Antonio lays hold upon him. He has some conscience still, but he is quickly satisfied by the sneer of Antonio, "I feel not this deity in my bosom." When they are surprised in their murderous attempt, Sebastian shows more boldness and self-possession.

Once entered upon a certain course, this standing water flows steadily enough.

In the seventh scene Sebastian still follows Antonio's lead. Instead of taking the lead in the dialogue, he is now the able henchman of the wily conspirator. The magic banquet and the shapes do not seem to move him very deeply. Lacking the power of original judgment, he accepts all his senses present with equal heartiness. After the vanishing of the shapes he exclaims bluntly:

> "No matter, since
> They have left their viands behind; for we have stomachs."

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After the denunciation of Ariel, he shouts :

" But one fiend at a time,
I'll fight their legions o'er."

In Act V Ariel, reporting the condition of the prisoners, tells Prospero " The King, his brother, and yours, abide all three distracted." When Sebastian stands in the charmed circle made by Prospero, he is charged with having furthered the plans by which Prospero and Miranda were so cruelly banished. He is spoken of as suffering most strong inward pinches of remorse.

When Prospero reveals himself he alludes threateningly to his knowledge of the later conspiracy against Alonso. But throughout the scene he is much harsher toward Antonio than toward Sebastian. When Ferdinand is found Sebastian exclaims, " A most high miracle! " Though this discovery greatly lessened his prospect of becoming his brother's successor.

After the entrance of Caliban and his boon companions Sebastian is found jesting light-heartedly enough with them, laughing, and endeavoring to rouse the spirits of the silent Antonio.

Sebastian is " high-stomached." He has a blunt, aggressive manner and, up to a certain point, has great ability as well as courage. But a certain coarseness of conception makes him offensive to finer natures, to whom he, in turn, stands in a relation of suspicious irritation. Not naturally bad, he has, however, no purpose except to live suitably in his position as the brother of Alonso. Led by a deep and conscienceless associate, clever to brilliance, he feels that he has discovered his true nature and becomes positively bad. His is the spirit of mercenary soldiers, or of a standing army, an immense force, capable of good or evil. Under the guidance of Antonio he appears as an extreme illustration of selfish aggressiveness as distinguished from selfishness of a more distinctly intellectual order.

Alonso : Conventional Egoism of Rank.

In the shipwreck scene the King's conduct is marked by dignity and propriety. " Good boatswain, have care. Where's the master? Play the men." Having seen that the duties of the situation are in the proper hands, he retires to his cabin and does not reappear.

Gonzalo reports the king and prince at prayers. It is clear that his example commands the respect even of Antonio and Sebastian, though they shortly after conspire to assassinate him ; such is the power of courtly discipline.

In the third scene Alonso is manifestly overcome with grief for his lost son and preserves a depressed taciturnity. After a long speech by Gonzalo, meant to comfort him, he says briefly, " Prithee, peace." After a prolonged silence, he is provoked to a longer reply by Gonzalo's well-meant persistence :

" You cram these words into mine ears, against
The stomach of my sense. Would I had never

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Married my daughter there! for coming thence,
My son is lost; and, in my rate, she too,
Who is so far from Italy removed,
I ne'er again shall see her. O thou, mine heir
Of Naples and of Milan! What strange fish
Hath made his meal on thee?"

When Sebastian reproaches his course in bestowing Claribel upon an African, he replies, "Prithee, peace." When he dwells upon the daughter's loathing, and concludes harshly, "the fault's your own," the King with admirable manner retorts "So is the dearest of the loss." His sole comment upon the honest old counselor's dream of a Kingless Commonwealth is: "Prithee, no more; thou dost talk nothing to me."

The solemn music of Ariel brings sleep to his careworn mind: While lamenting, in the manner of Bolingbroke, his restlessness, he becomes drowsy —

"What, all so soon asleep! I wish mine eyes
Would, with themselves, shut up my thoughts;
I find they are inclined to do so."

When aroused from a position of imminent peril he is dignified and vigorous. Having inquired of his officers regarding the disturbance, he thinks again of his son and begins further search for him.

The same scene makes very prominent the fact that the marriage of Claribel to the African was the cause of the disastrous voyage, and Sebastian persistently connects the violation of the girl's wishes with this misfortune. Alonso is made responsible for the match. Gonzalo confirms the truth of Sebastian's opinion, while regretting his cruel language. This sacrifice of a princess to selfish interest is the cause of the tempest.

In the seventh scene Alonso appears still searching for Ferdinand, but almost in despair. In a courtly speech to Gonzalo he says:

"Old lord, I cannot blame thee,
Who am myself attached with weariness,
To the dwelling of my spirits: Sit down, and rest.
Even here I will put off my hope, and keep it
No longer for my flatterer: he is drowned
Whom thus we stray to find; and the sea mocks
Our frustrate search on land. Well, let him go."

On hearing the music announcing the magic banquet he says: "What harmony is this? My good friends, hark!" and again, "Give us kind keepers, Heavens! What were these?" Later he says:

"I cannot too much muse,
Such shapes, such gesture, and such sound, expressing,

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Although they want the use of tongue, — a kind
Of excellent dumb discourse."

He declines Sebastian's rude invitation to taste of the banquet, but afterward with royal common sense he says:

"I will stand to and feed,
Although my last; no matter, since I feel
The best is past. — Brother, my lord the duke,
Stand to and do as we do."

The heavy indictment of Ariel and his awful threat crush Alonso to the earth.

"O it is monstrous! monstrous!
Methought the billows spoke and told me of it;
The winds did sing it to me; and the thunder,
That deep and dreadful organ-pipe, pronounced
The name of Prosper; it did bass my trespass.
Therefore my son i' the ooze is bedded; and
I'll seek him deeper than e'er plummet sounded,
And with him there lie mudded."

This is the perfect rhythm of despair, remorse and self-condemnation. The shattered nerves seem to moan forth an echo of Nature's most doleful harmonies through the words of Alonso.

In the last scene Alonso stands with the rest before Prospero's judgment-seat. It is observable that Ariel in Act III is more severe in his treatment of Alonso than is Prospero in this scene.

"Most cruelly
Didst thou, Alonso, use me and my daughter."

When Prospero appears as the wronged Duke of Milan, he treats the repentant King with real kindness. Alonso's speech in reply to Prospero's welcome is marked by a sincerity and decency which single him out from the "three men of sin" as the one capable of benefiting most by Ariel's words.

Alonso is curious to learn all from Prospero, but chiefly his mind dwells upon the fate of his heir; he is again in despair —

"I wish
Myself were mudded in that oozy bed
Where my son lies."

On seeing Ferdinand he fears to trust his senses. Being assured, he exclaims: —

"Now, all the blessings
Of a glad father compass thee about!"

He questions Ferdinand promptly about "this maid, with whom thou wast at play." Being satisfied that she is a desirable young person for Ferdinand's queen, he wel-

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comes her, but expresses his embarrassment at the obligation his noble manners put upon him of asking her forgiveness for his cruelty to her in her childhood. He says "Amen" to Gonzalo's pious wishes for the success of the young couple: "On this couple drop a blessed crown." He finds it difficult to accept what he now sees and hears as "natural events." Caliban amazes him, "This is as strange a thing as e'er I looked on." Caliban surely cannot be "natural."

He is on good terms with Prospero as the play ends, and desires to learn his whole story. These are all the chief facts narrated concerning Alonso. In no case does he fail in dignity of language or bearing. His constant references to his children suggest paternal love, but mingled with this is the love of making them powerful sovereigns who will perpetuate the greatness of his rule. He was willing to part with Claribel, and commanded her obedience in spite of her loathing, that she might marry a powerful barbarian. It is less his son than the heir of Naples and of Milan that he mourns. And it was through his intense pride of power and place that he took part in the cruel plot that won Milan for this heir; a dukedom which Ferdinand eventually inherits through his love for the princess so basely set adrift. A state such as Gonzalo dreams of with "no sovereignty" is repulsive to him. The world must offer kingdoms for himself and his chlidren to rule. Nothing seems of so great consequence to him as the perpetuation of his royal dynasty; hence there is no misfortune equal to the loss of his heir. He desires to be royal in his graceful language, in his manners, in his courage, in his respect for religion, and he succeeds so far as external forms reveal him. But when Ariel shows him his real worth and makes him the most prominent of the "three men of sin," his forms crumble into nothing and his convention is not a rock of strength. Here it is seen that he is rather here ditarily and passively bad, than black-hearted. And his nobility and severity, mingled with repentance and remorse, lend him a true royalty of character which quite reconcile us to him as the father of the hero.

Alonso is a faultless example of that form of pride and selfishness which is most consistent with dignity and a code of honor, formal and somewhat superficial, however bracing and constraining. He is the incarnation of respectable, conventional selfishness and formality.

Stephano and Trinculo: Two Types of Degeneration

"'I the commonwealth," says Gonzalo in Scene 3, "I would by contraries execute all things . . . .

No occupation; all men idle, all."

In the fourth scene we find two men idle, Stephano, the king's butler, and Trinculo, the king's fool. They had accompanied the king and the court to Africa, where it may be supposed their humor had increased the gayety of the wedding-feast. They do not appear in the shipwreck scene. In the dispersion following they are separated, to be reunited in Sc. 4. Prospero in Sc. 2 has insisted upon the necessity of active service, and the idleness of these renegades heightens the effect of his words.

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This necessity seems to be a phase of universal society, and not of dubious, provincial, or accidental morals.

Trinculo discovers Caliban, jests and moralizes. "When they will not give a doit to relieve a lame beggar, they will lay out ten to see a dead Indian." This is the philanthropic vein.

Stephano enters drinking, and singing a "scurvy tune." Seeing Caliban he declares himself a man of courage: "It hath been said, as proper a man as ever went on four legs cannot make him give ground; and it shall be said so again while Stephano breathes at 's nostrils." This is comical egotism. Stephano takes active measures to assist the monster to be sociable, and discovers Trinculo under the gaberdine. After much excellent foolery poor Trinculo comes forth and his joy upon seeing Stephano shows his kind, foolish heart. "And art thou living, Stephano? O Stephano! two Neapolitans 'scaped!" The need of a wine-bottle had developed Stephano's ingenuity, and he had made it with his own hands out of the bark of a tree.

The last fifty lines of the scene show Stephano attaching Caliban to himself by means of his bottle, his overbearing manner, and his humorous trick of playing on Caliban's superstition. In spite of their superior knowledge and very considerable experience of life, the two comrades appear inferior in integrity of instinct, and in simple enthusiasm, to the ridiculous monster. Trinculo's speeches throughout this part of the scene are all to the one effect — "an abominable monster."

The points common to Stephano and Trinculo are clearly indicated. Both are ignorant, low drunkards; both are humorous, and take the situation lightly; both are inclined to be good companions to the monster, but to gain money by the discovery of him. But the points of difference are not less definite. Stephano is coarse, egotistic, aggressive; Trinculo is effusive, weak, critical. Stephano refers everything he observes to himself and promptly asserts himself as master of the situation, "Here, bear my bottle." Trinculo is interested, theoretically at least, in the relief of lame beggars, and can only complain of Caliban's abominable ignorance in making a wonder of a poor drunkard: he cannot think so well of himself as Stephano.

In the sixth scene Stephano tells a different story of his escape from the shipwreck. In the fourth scene it was Trinculo who swam ashore like a duck; Stephano escaped upon a butt of sack. But now Stephano says:

"I swam, ere I could recover the shore, five-and-thirty leagues, off and on, by this light." This gives point to Trinculo's pun "But you'll lie like dogs, and yet say nothing neither." Stephano in Sc. 4 calls Trinculo "fellow Trinculo," but having the support of his lieutenant Caliban he now says: "If you prove a mutineer, the next tree!" Whereafter Trinculo's place in this republic rapidly becomes one of extreme subordination. When Stephano and Caliban have arranged the plot against the life of Prospero, Stephano says, "Dost thou like the

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plot, Trinculo?" But Trinculo, whatever his sentiment concerning lame beggars, is constrained to reply: "Excellent." When Ariel's music is heard, Trinculo exclaims, "O, forgive me my sins;" Stephano says, "He that dies pays all debts; I defy thee, — Mercy upon us!"

In the eighth scene Trinculo and Stephano are equally agitated by their misadventures, and especially by the loss of their bottles. Trinculo is commanded to give up a gown to which he has a fancy. He promptly obeys. When Trinculo makes a jest, Stephano rewards him with a garment as grandly as a great monarch might give a pension to a man of genius.

The glistering garments have more value in the eyes of these court dependents than in those of the savage Caliban.

Toward the end of the fifth act Ariel enters, driving in Caliban, Stephano, and Trinculo, in their stolen apparel. Stephano's first words are: "Every man shift for all the rest, and let no man take care for himself, for all is but fortune." Prospero says to Alonso: "Two of these fellows you must know and own," these were conventional productions.

Trinculo's experiences in idleness conclude with the words, "I have been in such a pickle since I saw you last that, I fear me, will never out of my bones; I shall not fear fly-blowing." Stephano, whose humor is quite equal to that of the professed jester, replies to Prospero's "You'd be the King of the isle, sirrah?" "I should have been a sore one then." The irresponsible light-hearted conduct of these two fellows redeems in some degree their vileness; but their murderous plot shows them to be dangerous elements in the society of the island.

The weak, silly buffoonery of Trinculo, stamps him as a degraded and backward character of the unselfish class, bad through his lack of virtue and force rather than through the desire to injure anyone. With virtue and enlightenment one may fancy him kindly and charitable.

Stephano is equally degraded and sensual, but has some force, given him by a strong selfishness.

Both are jolly and sociable in spite of their disgusting villainies, and both their good and bad qualities seem to be intensified by their excessive love of the celestial liquor.

Adrian and the Minor Characters

Adrian has no spoken part in the first scene. Almost all the facts recorded of him are found in the third scene. Gonzalo is making conversation in his cheerful, if tedious, manner when Sebastian and Antonio begin to scoff openly at his efforts. It is Antonio who says, "Which of he or Adrian, for a good wager, first begins to crow?" "The old cock," replies Sebastian; Antonio chooses "the cockerel." Adrian's speech, interrupted by the chaff of the others, runs as follows: "Though this island seems to be desert, uninhabitable, and almost inaccessible, yet it must needs be of subtle, tender, and delicate temperance. The air breathes upon us

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here most sweetly." Gonzalo comes to his rescue and mentions more substantial benefits of nature in order to silence their ridicule. Adrian takes no part in the discussion of the incredible preservation of the garments. But he gently opposes Sebastian's sarcastic allusion to the marriage of Claribel: "Tunis was never graced before with such a paragon to their queen." This is, in the words of Sebastian, "most learnedly delivered." But the next speech of Adrian is an illumination: "Widow Dido, said you? You make me study of that; she was of Carthage, not of Tunis." Gonzalo boldly answers: "This Tunis, sir, was Carthage." But the learned Adrian, who speaks with such discrimination of the subtle, tender, and delicate temperance of the island, and who knows the history of Tunis, merely raises his eyebrows and protests gently, "Carthage?"

In the seventh scene Adrian speaks but once. His words echo the request of Gonzalo to those of suppler joints to follow and preserve the King and the two other "men of sin."

In the last scene Sebastian and Antonio enter into the magic circle, attended by Adrian and Francisco. The character of Adrian is thus slightly, but rather firmly, sketched. His shy, retiring manner is vividly contrasted with the bold aggressiveness of Sebastian, who delights in teasing him. His belief in the sufficiency of Nature, or rather of mere landscape, to supply man with sufficient pleasure to arouse his gratitude and satisfy the longings of his heart; his pedantic accuracy concerning Dido and Carthage; his timid but too expressive manner of asserting his dissent; his friendly attitude toward Gonzalo, than whom, however, he is much less robust, indicate a character of the most refined and delicate culture. He corresponds to that phase of Prospero which is associated with his library, and his solitary studies on the island: he is a mingling of learning and gentleness.

Francisco speaks twice in the course of the play. In the third scene he endeavors to inspire the King with hope concerning Ferdinand, after Gonzalo has been unsuccessful.

> "Sir, he may live;
> I saw him beat the surges under him,
> And ride upon their backs; he trod the water,
> Whose enmity he flung aside, and breasted
> The surge most swoln that met him; his bold head
> 'Bove the contentious waves he kept, and oar'd
> Himself with his good arms in lusty stroke
> To the shore, that o'er his wave-worn basis bow'd,
> As stooping to relieve him. I not doubt
> He came alive to land."

This speech produces no effect upon Alonso.

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In the seventh scene Francisco, upon the disappearance of the shapes, remarks: "They vanished strangely." Upon this very slight evidence it is possible to form but a vague idea of the character of this lord. The turgid weakness of the speech to Alonso indicates a strong desire to please and cheer his sovereign. His language suggests that he is an admirer and imitator of fine expression. He is loyal to the convention that shelters him, and a harmless, well-meaning gentleman; but in the action rather a typical nonentity; a formalist, but not selfish.

The sailors appear in the first and ninth scenes of the play. The master says nothing after summoning the boatswain, warning him of the peril, and calling for active exertions. The commands given concerning the management of the ill-starred ship are such as to rouse the approval and admiration of Elizabethan seamen critically observing from the pit of the theater.

The boatswain gives a great air of reality and simple interest to the first scene. It is perhaps worth notice that the king calls him "boatswain," while Antonio calls him "boson." Such a distinction illustrates the refined quality and artistic significance of the characterization of the play; for it can hardly be accidental that the dignified Alonso uses the longer form.

The boatswain is prompt, obedient, cheerful, breezy, bold: "Here master, what cheer?" he says, and to the men, "High my hearts! cheerly, cheerly, my hearts! yare, yare! Take in the topsail. Tend to the master's whistle." But turning to the storm he says, "Blow, till thou burst thy wind, if room enough!" He saw at a glance the danger that they might drift onto the rocks in trying to make their way out to sea. Stephano's story of swimming five and thirty leagues shows a capacity for boasting that reminds one of Falstaff's men in buckram.

In a word, the boatswain is vigilant, capable, and on excellent terms with the men. He does his duty perfectly without philosophizing about it. He resents the selfish interference of the nobles. They must think their lives more important to him than his own, and he feels this distinctly enough. When Mr. Pickwick fell through the ice, Miss Arabella desired him to save himself for her sake; but Mr. Pickwick could think of another strong reason for his best endeavors. Self-preservation is an instinct. Stephano's "every man shift for all the rest, and let no man take care of himself," in spite of its humorous cunning egoism, is not further from the normal human instinct than the injunctions of the nobles to the boatswain. There is none aboard that the sailor loves more than himself. In this peril all are on a natural footing; if the superiority of those in authority is real and not conventional, let them save the ship. Such is his illogical argument, and not without a kernel of plain truth.

When the boatswain has done his best for the general weal and the sailors have lost hope, the brave tar inquires, "What, must our mouths be cold?" and for this he is called a drunkard and charged with cheating the nobles of their lives.

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In the ninth scene the honest sailor reveals his true feelings and they have no stain of malice.

> "The best news is that we have safely found
> Our king and company; the next, our ship, —
> Which but three glasses since we gave out split, —
> Is tight and yare and bravely rigg'd as when
> We first put out to sea."

His account of his liberation is marked by the same hearty interest in his experiences, childlike unconsciousness of himself, and simple manly good-will.

The boatswain is briefly portrayed, but the details are rich in significance. (The subtle truth, with which the primary human instinct, refined by the labor and discipline of a wholesome sea-faring life, is made the dominant note of this character, requires study for its appreciation.) The boatswain illustrates a class of plain, honest people who find their own good in humbly serving the society to which they belong, but value themselves as men in spite of their subordinate place. It is a long cry from the Boatswain to Prospero, but eqally from Caliban to the Boatswain.

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ON THE IONIZATION DUE TO THE EMANATION OF RADIUM[1]

By William Duane

If radium emanation is introduced quickly into a suitable testing vessel, the saturation current that can be made to pass through the air contained in the vessel increases rapidly during the first ten minutes, then more slowly, and attains a maximum value at the end of about three hours. Theoretically, the relation between the current i and the time t, counted from the moment the emanation enters the vessel, should be of the form

$$i=A+Bf(t). \qquad (1)$$

The second term corresponds to the progressive production of the induced radio-activity. A and B depend upon the form of the testing vessel and upon the quantity of emanation employed; they remain constant as long as the emanation has not diminished perceptibly. Using the expression for $f(t)$ given by MM. Curie and Danne[2] we may write:

$$i=i_o\left\{\alpha-\beta\left[\lambda e^{-\alpha t}\mu\left(\frac{c}{b-c}\,\frac{e}{a-b}e^{-bt}-\frac{b}{b-c}\,\frac{e}{a-c}e^{-at}\right)\right]\right\} \qquad (2)$$

with the conditions:

$$\alpha-\beta=1, \qquad \lambda-\mu\left(\frac{c}{b-c}\,\frac{e}{a-b}-\frac{b}{b-c}\,\frac{e}{a-c}\right)=1$$

The constants b and c are known very accurately. In order to determine the two ratios α/β and λ/μ, the saturation currents were measured in suitable testing vessels by means of an electrometer and a piezo-electric quartz, the readings being taken each minute during the first ten minutes and thereafter less frequently. The following table contains the observed currents, and those calculated from equation (2), using the values

$a=.00401$	$b=.000538$	$c=.000413$	$i_o=43.1$
$\alpha=2.37$	$\beta=1.37$	$\lambda=.570$	$\mu=.438$

and the second as the unit of time.

[1] An account of the experiments described in this article was presented to the French Academy on February 27, 1905. The experiments were made in M. Curie's Radium Laboratory.

[2] *Comptes Rendus*, March 14, 1904.

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Time t	1	2	3	4	5	6	7	8	9	10	20	30	180
Measured Current	50.3	56.1	60.5	63.9	66.6	68.6	70.4	71.8	72-9	73.8	77.7	80.9	100
Calculated Current	50.3	55.9	60.3	63.6	66.4	68.7	70.4	71.7	72.9	73.8	78.3	80.8	...

The measured currents are the means of value obtained in ten separate experiments, and, as a matter of fact, agree with the calculated values to within ½ per cent during the first ten minutes and to within 1 per cent during the following twenty minutes.

In equation (2) i_0 is the value of i when $t=0$, and in what follows we assume that i_0 represents the saturation current due to the emanation alone. β is approximately equal to the ratio of the currents due respectively to the induced activity and to the emanation when they are in radio-active equilibrium, and λ/μ is practically equal to the ratio of the currents due, respectively, to the first and third of the successive components of the induced radio-activity (in the theory of transformations.)

The constants α, β, λ and μ are functions of the dimensions of the apparatus, although they vary little if large testing vessels are employed, such as was the case in the experiments described below. When the current has reached its maximum value, about 42 per cent of it is due to the emanation, 33 per cent to the first and 25 per cent to the third of the components of the induced radio-activity.

The quantity of emanation produced by a radium salt is proportional to the weight of the salt and to the time. We define the unit quantity of emanation to be that emitted during one second into a large volume of air from a solution of small volume containing one gram of radium bromide. If the time during which the emanation is allowed to accumulate is not short, it is necessary to make a correction for the amount of emanation transformed during that time.

It is important to know the amount of ionization produced by the unit quantity of emanation, for this datum may be used in quantitative tests for radium.

If the emanation is enclosed in a testing vessel a part of its radiation is absorbed by the sides of the vessel. In order to determine the effect produced by the sides, three cylindrical vessels of zinc were constructed. In the axis of each cylinder an insulated zinc rod was

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fastened to serve as an electrode. The largest cylinder contained 51 liters of air and the smallest about one-half a liter. The length of each cylinder was about twice its diameter. The saturation currents in these vessels were measured at intervals after the introduction of a known quantity of emanation, and from these data the initial value of the current was calculated by means of equation (2). These initial currents are quite accurately represented by the equation

$$I = I_o - k\frac{S}{V}, \qquad (3)$$

S being the surface of the vessel, V its volume and I_o and k constants. If each vessel contains unit quantity of emanation, the value of k is .326 and that of I_o .63 in electrostatic units and at 18° C. and 76 cm. pressure.

Equation (3) may be interpreted as follows: We may assume that the radiation absorbed by the sides and the secondary radiation produced at the metal surface are proportional to the area of the surface and to the quantity of emanation contained in a cubic centimeter of air. If each vessel contains the same total quantity of emanation, the quantity per cubic centimeter is inversely proportional to the total volume. The effect produced by the sides is therefore proportional to the ratio of S to V. The quantity I_o is the saturation current that would be produced by the unit quantity of emanation, if all its rays were absorbed in air. The constant k is positive, which shows that the absorbing effect of the sides is greater than the effect caused by any secondary radiation that may be produced.

In obtaining the above values of I_o and k the emanation evolved during two hours by a solution of .0001096 gram of radium bromide, *i. e.*, about .79 of a unit, was used. The volume of the solution was one cubic centimeter and that of the reservoir of glass that contained it about thirty cubic centimeters. In order to establish a permanent state the precaution was taken of drawing air several times through the reservoir at intervals of two hours before collecting the emanation for use in the experiments. Two other solutions also have been used containing respectively .000110 gram and .0000127 gram of radium bromide dissolved in five cubic centimeters of water. The correspond-

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ing values found for I_o were .61 and .60, and for k .316 and .311. These results are quite close to those given above. However, the measurements are more regular when the radium salt is dissolved in a smaller quantity of water, as in the first experiments.

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THE CRANIAL NERVES OF ONE OF THE SALAMANDERS (*Plethedon glutinosus*)

By Gideon S. Dodds

Among Urodelan brains, probably those of *Necturus* and *Proteus* have been most studied. Work has also been done upon *Diemyctylus viridescens*,[1] *Desmognathus fusca*, *Amblystoma tigrinum*, *Amphiuma*, and others. The family Plethedontidæ, comprising thirty-five species,[2] has been little studied. So far as I can learn, the only work done in this family is a study of the cranial nerves of *Spelerpes bilineatus* by Mary A. Bowers.[3]

The brain of *Plethedon glutinosus* presents no very striking differences from those of other Urodelans. The general appearance of the dorsal aspect of the brain, and the place of origin of the cranial nerves is shown in figure 1. This brain measures 7 to 9 mm. in length and 2 to 2.5 mm. in width at the widest part. Owing to its small size, it is necessary to use microscopic methods in its study. The present investigations were made from serial sections through decalcified heads. In the following account is given a brief description of the cranial nerves of *Plethedon glutinosus*, including their apparent place of origin and relations of the principal branches. These features are shown in figure 2.

I. The mode of origin of the *olfactory* nerve varies in Urodela, sometimes arising by one root, and sometimes by two. In *Plethedon glutinosus* it arises by two roots. The main root arises from the cephalo-lateral angle of the olfactory lobes toward their ventral aspect. The second, very much smaller root, arises some little distance back, from the lateral surface of the brain. After a short course forwards, the nerve divides into two branches, which innervate the roof and floor

[1] The writer is indebted to Prof. Burt G. Wilder, through whose kindness he secured a valuable paper bearing on the subject.

[2] D. S. Jordan. *Manual of the Vertebrates, etc.* Eighth edition. 1899.

[3] Noted by Coghill. *Jr. Comp. Neur.*, 12: 285. 1902.

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of the olfactory capsule. This is the largest of the cranial nerves. It contains no medullated fibers.

II. The fibers of the optic chiasma lie sunken in the ventral surface of the diencephalon. This is common in Urodela, in distinction to the condition in Anura, where the chiasma makes quite a prominence. The fibers of the optic nerve, after crossing, spread out to form the surface layer of white matter of the roof and sides of the mesencephalon. Beyond the chiasma, peripherally, the nerve passes antero-cephalad to its foramen. After leaving the cranium, it turns abruptly downwards and passes under the ophthalmic branch of V, and after a short lateral course enters the eyeball. The fibers of this nerve are, in the main at least, non-medullated. Throughout its course, the nerve has a core of glia cells. These are a direct continuation of the cells lining the preoptic recess, and are a remnant of the cells of the primitive eye-stalk. In *Necturus*, a more primitive form, the eyes and optic nerve are not so well developed, and the embryonic condition is more strongly suggested than in *Plethedon*.

III. The *oculo-motor* nerve arises from the ventro-lateral aspect of the mesencephalon. At its exit from the brain it is about 75 microns in diameter. It takes a course forward and dorsalward to its foramen, some distance in front of the exit of V. In its foramen it divides into the superior and inferior rami. These pass forward for some distance, one just above and the other just below the ophthalmic branch of V. Then they turn outward to the muscles of the eye.

IV. The *trochlear* is the smallest of the cranial nerves, measuring 36 microns in diameter and consisting of about twenty fibers. It arises from the line of union between the mid-brain and cerebellum near the mid-dorsal line. In some Urodela this nerve has not been observed, and in others it has not been traced to its exit from the cranium. In *Plethedon*, though small, its course can be clearly traced. From its place of origin, it takes a course latero-cephalad till it comes in contact with the Gasserian ganglion. It passes forward just beneath the mesial surface of the ganglion as a small but distinct bundle, and neither gives nor receives fibers from the ganglion. From here it leads forward and upward along the inner surface of the cranium and

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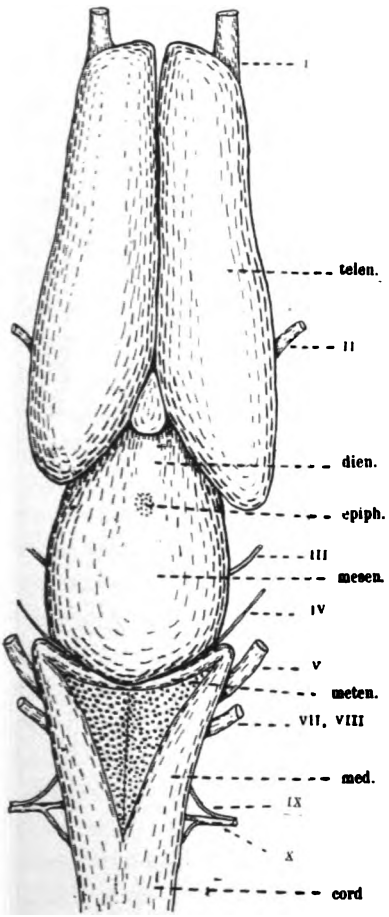

Fig. 1

Fig. 1. Dorsal view of the brain of *Plethedon glutinosus*. X 12

I-X, the cranial nerves; telen, telencephalon; dien., diencephalon; mesen., mesencephalon; meten., metencephalon; med., medulla oblongata; cord, spinal cord; epiph., epiphysis.

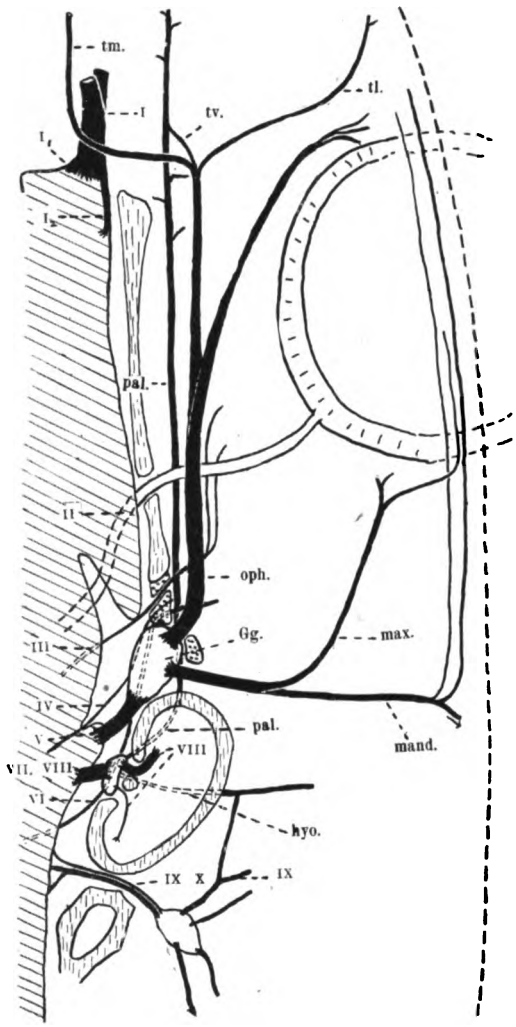

Fig. 2

Fig. 2. Diagram of the cranial nerves of *Plethedon glutinosus*. X 12

Oblique shading represents the brain; vertical shading, bone; dotted shading, cartilage. The broken line represents the outline of the head; I-X, the cranial nerves; Gg., Gasserian ganglion; hyo., hyo-mandibular; max., maxillary; mand., mandibular; oph., ophthalmic; pal., palatine; tl., tm., and tv., lateral, mesial and ventral, terminal branches of V.

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makes its exit through the lateral edge of the parieto-frontal bone. Outside the cranium its course was traced only a short distance.

V. The *trigeminus* is, next to the olfactory, the largest of the cranial nerves. It arises from the antero-lateral angle of the medulla, and passes forward and outward to the Gasserian ganglion. This large ganglion lies inside the cranium just back of the posterior extension of the cerebral hemispheres. In some Urodela, it is described as lying inside the cranium, in some as lying in the foramen, and in others as lying outside the cranium. Arising from the ganglion are the three usual branches. They make their exit by two foramens. In the manner of exit of these branches there is considerable variation in Urodela. They may pass out through one, two, or three foramens. In *Plethedon* the maxillary and mandibular branches leave the cranium through a common passage in a lateral direction and the ophthalmic by a separate passage in a forward direction.

The ophthalmic takes a course directly forward just outside the cranium. It soon divides into two branches. One of these extends dorso-lateral and breaks up in the muscles in front of the eye. In the accounts of this nerve in other Urodela, I find no description of this nerve. It is probable, however, that it is represented in *Amblystoma* by three small twigs described by Coghill.[1] The other branch of the ophthalmic continues forward, and at about the level of the anterior part of the brain it breaks up into three terminal branches, mesial, lateral, and ventral. The mesial terminal branch turns inward and then extends forward in the floor of the nasal capsule to innervate the gland of the snout. The lateral terminal branch passes forward near the surface of the antero-lateral part of the snout. The ventral terminal branch soon unites with the palatine branch of VII. From here it continues forward to innervate the anterior part of the roof of the mouth.

As before noted, the maxillary and mandibular make their exit by a common foramen. The maxillary is dorsal, and is by far the smaller of the two. It passes off laterally and curves forward in two parts.

[1] G. E. Coghill. "The Cranial Nerves of Amblystoma tigrinum." *Jr. Comp. Neur.*, 12: 220, 221. 1902.

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One branch (infra-orbital) breaks up back of the eyeball, and the other (maxillary) passes forward a little above the maxilla. The mandibular passes off laterally and soon curves ventralward to the maxilla, where it breaks up into three branches. Two of these remain in the upper jaw and pass forward well into the snout, one just external to, and the other just internal to the maxilla. The distribution of this nerve in *Plethedon* seems to be exceptional. I am unable to find an account of any other form in which this large part of this nerve remains in the upper jaw. These two branches may possibly represent a part of the maxillary ramus. The third branch, about equal in size to the other two combined, passes ventralward into the lower jaw.

VI. The *abducens* arises, as usual, from near the mid-ventral line of the medulla, a short distance back of VIII. It is a slender never, raveaging about 65 microns in diameter. It takes a course forward and dorsalward and passes just below the ganglion of VII–VIII, and below the Gasserian ganglion. In this respect *Plethedon* seems to be exceptional, inasmuch as this nerve is usually described in amphibia as passing through the Gasserian ganglion. It makes its exit from the cranium in front of the ophthalmic branch of V.

VII, VIII. The *facial* and *auditory* arise by a common trunk, from the lateral surface of the medulla just back of V. The combined trunk, after a short course in an antero-lateral direction, enters its ganglion, which is composed of the geniculate and auditory ganglia. From the ganglion, four nerve trunks make their exit, two of which belong to VII and two to VIII.

The branches of VII are the palatine and hyo-mandibular. The palatine passes forward in the roof of the mouth, to which it gives off branches. Its union with the ventral terminal branch of V has been described under V. The hyo-mandibular trunk of VII passes outward under the ear capsule and then curves downward to the lower jaw. A little distance from its foramen, it gives off a branch backward which, after a short course, unites with IX. This anastomosing branch between VII and IX is quite common in amphibia. A branch of VII uniting with the Gasserian ganglion is uniformly described for amphibia. I failed to find this branch in *Plethedon*.

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The auditory nerve enters the ear capsule in two parts. The main part turns forward to the anterior part of the capsule, and the other part, a small twig, enters by a separate foramen and turns backward. Kingsbury[1] describes in *Necturus* a small part of VIII, which enters by a separate foramen and immediately unites with the main part of of the nerve. In the accounts of this nerve in all other Urodela only one part is mentioned.

IX-X. Just back of VII–VIII there arise three separate roots from the lateral part of the medulla. The nerves arising from these roots unite later in a common ganglion. These are the roots of the *glossopharyngeal* and *vagus*. The anterior of these roots is the smallest and enters the ganglion as a separate nerve. The other two unite into a common trunk before entering the ganglion. Near the inner end of the ganglion there arises from its anterior surface a nerve composed, largely at least, of fibers from the anterior root. It passes off in a latero-ventral direction. Not far from the ganglion, it receives the branch from VII. This nerve is probably the glossopharyngeal. The remaining three branches constitute the vagus.

[1] B. F. Kingsbury. "On the Brain of Necturus maculatus." *Jr. Comp. Neur.*, 5: 148. 1895.

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THE SEED AND SEEDLING OF THE MOUNTAIN GLOBE-FLOWER

By Francis Ramaley

The mountain globe-flower, *Trollius albiflorus* (A. Gray) Rydberg,[1] is limited in range to the mountain districts of western North America. It grows in wet or swampy ground, where the water is cold, and is often found with our white-flowered *Caltha* (*C. rotundifolia*). Frequently it occurs in slow-running water under spruce trees. The writer has not seen it in Colorado at an altitude of less than 9,500 feet. In Montana, according to Rydberg, it occurs at 6,500 feet. When in full bloom a mass of these plants forms a striking feature of a forest scene. The flowers are white, and there are many on each plant.

Each carpel of the flower produces a great many of the small, ovoid black seeds. A ripe seed is about 1.7 mm. long, somewhat angled, and striate with irregular ribs. The embryo is small and placed at the narrow end of the seed (Fig. 1). The endosperm cells are densely packed with aleuron grains. A considerable amount of oil is present. The cells immediately surrounding the embryo are somewhat more oily than the rest. This region is marked by the dotted line in Figs. 2 and 3. The embryo, carefully dissected out, is found to show but slight differentiation (Fig. 3). The cotyledons may be recognized, but they show no similarity to leaves. At this stage in its development the young plant has no vascular tissue.

The seedling is peculiar in that the cotyledon-stalks are united from the base upward for about half their length. The stem axis is thus surrounded and covered over by the united bases of the stalks. It is through a slit in this "cotyledonary sheath" that the plumule escapes. A similar condition obtains in *Trollius ledebouri* as described by Lubbock.[2] Certain other Ranunculaceæ also have the cotyledon-

[1] *Cat. Flora of Mont. and Yellowstone Nat. Park*, 152. 1900. [2] *Seedlings*, 1: 91. 1892.

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stalks thus united. Miss Ethel Sargant[1] has recently published a provisional list of plants which show this peculiarity.

From a glance at Fig. 4 the general structure of the seedling will be understood. The hypocotyl is short; the primary root is soon replaced by a number of adventitious roots. All parts of the plant are glabrous, or nearly so, although the leaves bear a few short trichomes to be seen only with the compound microscope (Fig. 8). From the very first the leaves are palmately cleft and toothed; later leaves are more deeply incised (Fig. 13). The cotyledons have the usual Ranunculaceous form, being oval or elliptical in outline. In texture they are herbaceous. Veins in the cotyledons are only recognized with ease after the specimens have been in alcohol for a time.

Certain differences are apparent in the structure of the epidermis of the leaves and cotyledons, as will be seen by a glance at the figures. In the cotyledon, the epidermis of the upper (Fig. 5) and lower (Fig. 6) surfaces is much alike. The cell outlines are quite wavy. Some stomata are present on the lower surface, while none are to be seen above. As would be expected, the leaf shows a more specialized condition. The cells of the upper surface have only a slightly wavy outline (Fig. 7), and there are no stomata. On the other hand, the lower epidermis is made up of cells with very wavy outlines, and there are numerous stomata and some short, club-shaped trichomes (Fig. 8).

In studying vertical sections of the leaf-lamina (Fig. 9) and blade of the cotyledon (Fig. 10) marked differences are seen. A distinct palisade of vertically elongated cells is found in the former, and a few of these palisade cells are branched above so as to be **V** or **Y** shaped. No true palisade is formed in the cotyledon, but instead there are about two rows of rather spherical cells very loosely arranged with large intercellular spaces. The vascular tissue of the cotyledon is slight in amount, the bundles being quite small.

The cotyledon-stalks are united for about half their length in the same way as those of *Delphinium occidentale*, described by the present writer.[2] A similar condition has recently been noted by Miss Neata

[1] *Annals of Bot.* 17: 73. 1903. [2] *Minn. Bot. Studies.* 2: 417-421. 1900.

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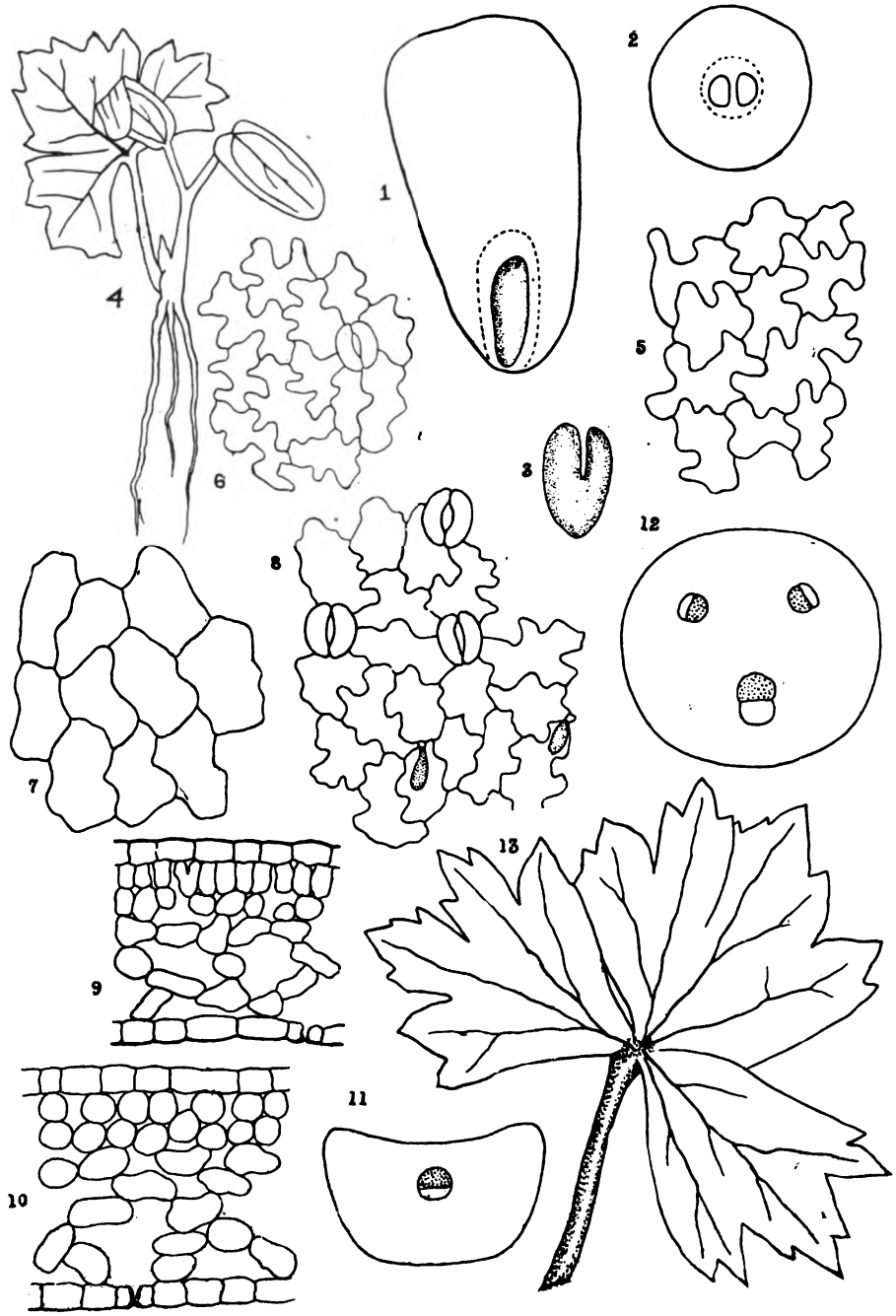

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Clark[1] in *Oxygraphis cymbalaria*. Each stalk (Fig. 11) is channeled above and contains a single small vascular bundle. The petiole of the first foliage leaf is semi-terete. It has three vascular bundles, the lower one the largest. In later leaves the bundles are numerous, as many as six or eight large ones and a number of smaller size.

The principal points of interest in the foregoing account may be briefly summarized. *Trollius albiflora*, in germination, offers an example of united cotyledon-stalks. The plumule makes its appearance through a slit at the base of the connate stalks. Although the cotyledons are foliaceous in appearance they are very different in shape from the leaves. A more specialized structure is observed in the leaf than in the cotyledon, the former having a well-marked palisade and the epidermis being strikingly different on the upper and lower surfaces. The cotyledon-stalks have each a single vascular bundle, while the leaf-petiole of the first leaf has three bundles and later leaves still more.

EXPLANATION OF FIGURES

1. Vertical section of the seed x 55. The embryo is seen, imbedded in endosperm, which is somewhat more oily close to the embryo.
2. Cross section of the seed, through the embryo, x 55. The cotyledons are shown surrounded by the more oily portions of the endosperm.
3. Embryo, dissected out x 55.
4. The seedling x 2. Note the absence of main root; the connate cotyledon-stalks; the first leaf and bud appearing through a slit in the cotyledonary sheath. In shape, the first leaf is seen to differ from the later leaf (Fig. 13).
5. Surface view of upper surface of cotyledon. All the cells of the epidermis have wavy outline.
6. Surface view of lower epidermis of cotyledon. This has much the same appearance as Fig. 5. Stomata are, however, present.
7. Surface view of upper epidermis of leaf. In this the cell outlines are less wavy than in the corresponding epidermis of the cotyledon.
8. Surface view of lower epidermis of leaf. Here are found very wavy cell outlines, numerous stomata, occasional short, clavate trichomes.
9. Vertical section of leaf-lamina. A distinct palisade layer is present. In this layer one cell is shown which is branched above.
10. Vertical section of blade of cotyledon. In place of the distinct palisade found in the leaf, there are two rows of nearly spherical cells with large spaces between them.
11. Diagram of cross section of cotyledon-stalk, made above the region where the two stalks are connate. There is one small vascular bundle.
12. Diagram of cross section of petiole of first leaf. In this there are three vascular bundles. Attention should be called to the fact that in later leaves the vascular bundles are numerous.
13. Drawing of an adult leaf, one-half natural size. It is interesting to note that the shape is quite different from that of the first leaf.

All the drawings were made by the author from his own preparations. Figures 5 to 10 show a magnification of about two hundred and fifty diameters.

[1] *Torreya*, 5: 164-166. 1905.

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VOLUME III NUMBER 3

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

JUNE, 1906

Price, 50 Cents

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PRINTED AT
THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

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A PRELIMINARY BIBLIOGRAPHY OF COLORADO HISTORY

By Frederic Logan Paxson

The materials relating to the history of Colorado have never been described in a systematic manner and remain unnoticed in our libraries in the form of books, chapters, and magazine articles. The official records of the state have received some attention in "The Public Archives of the State of Colorado," by F. L. Paxson, in the *Annual Report of the American Historical Association*, 1903, Vol. I, pp. 414–437. A beginning has also been made in the bibliography of formal books relating to the history of the state, by the same writer in his "The Historical Opportunity in Colorado," in the *University of Colorado Studies*, Vol. III, pp. 19–24. But no attempt has thus far been made to arrange the magazine articles and public documents in any sort of order. This last work is the purpose of this present paper, but no claim for an exhaustive bibliography is here made. It is hoped that the most important articles have been found and listed, but in some directions the collection is avowedly partial, while in all it is only preliminary.

The land which is incorporated in Colorado has been acquired at various times from France, Mexico, and Texas, the steps being recorded in F. L. Paxson, "The Boundaries of Colorado," in the *University of Colorado Studies*, Vol. II, pp. 87–94. The actual survey of the southern boundary touching New Mexico and Oklahoma was long deferred, the attempts to provide for it being described in H. Doc. 604; 57C.1; Serial 4377; May, 1902,[1] and H. Doc. 120; 57C.2; Serial 4489; December, 1902. So much of the land as lies between the Rio Grande and the Arkansas, and the meridians of their sources, was bought from Texas on September 9, 1850. The existence of various Mexican grants in this region has been a source of

[1] This reference, and all others to the public documents, should be expanded in this manner: House Document 604; Fifty-seventh Congress, First Session; Serial No. 4377.

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annoyance to the United States because of a confusion as to lands east and west of the Rio Grande, the latter having been acquired from Mexico in 1848, and the grants therein being under the guarantee of the treaty of Guadaloupe Hidalgo. In 1886 the Committee on Private Land Claims recommended the erection of a special tribunal to handle these claims, H. Rep. 1380; 49C.1; Serial 2439. Two years later this same committee presented a second report to the same effect, stating that three millions of acres of Colorado lands were claimed under grants from Spain and Mexico, H. Rep. 675; 50C.1; Serial 2600; and finally in 1892 the same committee again reported to the House on the status of litigation over the Vigil, Maxwell, St. Vrain, and other grants, calling attention to the fact that the land policy of the United States had overlooked the Texan origin of the Colorado lands east of the Rio Grande, H. Rep. 1253; 52C.1; Serial 3045.

The geographical and geological foundations for the history of Colorado are well laid in the government documents. In general, it is necessary to call attention to the irrigation papers among the *Bulletins of Experiment Stations, Department of Agriculture*, and to the *Bulletins of the United States Geological Survey*, many of which relate to Colorado. There is a good bibliography of the various exploring parties that have worked in Colorado in pp. 18–26 of G. H. Girty, "The Carboniferous Formations and Faunas of Colorado," H. Doc. 479; 57C.2; Serial 4511; pp. 546. A resolution of the legislature of Colorado asking for a federal department of mines, with the comment of the Director of the Geological Survey upon the request, is in Sen. Doc. 170; 55C.1; Serial 3563; pp. 8. The Secretary of War reported to Congress in 1897 upon reservoir sites in Wyoming and Colorado, giving a general history of irrigation works, H. Doc. 141; 55C.2; Serial 3666; pp. 110; while A. L. Fellows, in *Water Supply and Irrigation Papers*, No. 74, has an exhaustive description of the "Water Resources of the State of Colorado," H. Doc. 200; 57C.2; Serial 4500; pp. 151. The economic historian will find much comfort in the annual *Statistics of Mines and Mining*, prepared by the federal Commissioner of Mining Statistics, the eighth annual being 1875, H. Ex. Doc. 159; 44C.1; Serial 1691.

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The first few years of the life of the Territory of Colorado were passed in an obscurity that has rarely been driven away. Little interest was shown in the territory at the time, or since, and thus few articles have to be recorded for the period. Among the most interesting articles upon the period of settlement is the avowed forgery by "Fitz-Mac," which appeared in the *Colorado Magazine*, Vol. I, pp. 281–297, July 1893. This local magazine, which lived for only five months in the summer of 1893, was far beyond most similar journals in typographical and literary character. The article in question purported to be a series of six letters, written chiefly in the years 1859–1860, by early settlers in Denver. Although the author admitted that the letters were an honest fabrication, the descriptive value of the series is great, for "Fitz-Mac" showed an intimate acquaintance with the personnel and conditions of the short-lived territory of Jefferson.

Much of the literature produced in these first years was called forth by the various attempts at statehood made in the Pike's Peak country. As early as February, 1861, this matter was stirred up by B. D. Williams, who appeared in Washington and sought recognition as a territorial delegate. The memorials which he presented to Congress contain descriptions of the new settlements and a copy of the message of Richard W. Steele, governor of the provisional territorial organization of Jefferson Territory. They may be found in H. Misc. Doc. 10; 36C.1; Serial 1063. The same spontaneous territorial movement is described in a brief paper on "The Territory of Jefferson," by F. L. Paxson, in the *University of Colorado Studies*, Vol. III, pp. 15–18. The original materials for the period are not copious. The message of General Gilpin, the first territorial governor, is printed in H. Ex. Doc. 56; 37C.2; Serial 1131; while in the same month, February, 1862, a six-page report from the Committee on Ways and Means, H. Rep. 36; 37C.2; Serial 1144, advocates the establishment of a branch mint in Denver. The great production and use of raw gold, together with the existence of a private mint, were the reasons leading the committee to its recommendation.

From 1864 to 1867 various attempts to bring Colorado into the United States occupy most of the time. An enabling act was passed

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in 1864, but the constitution framed in accordance with it was rejected at the polls. The following summer saw a change of feeling, bringing with it a new and ratified constitution; but President Johnson declined to issue the proclamation of admission on receiving it, on the ground that the time for such action had expired. He transmitted the constitution with extracts from the reports of the convention and his reasons for refusing to act in Sen. Ex. Doc. 10; 39C.1; Serial 1237, on January 12, 1866. Congress followed this message by passing a second enabling act for the territory, only to receive back this act with a veto message of May 16, 1866. The printed message, Sen. Ex. Doc. 45; 39C.1; Serial 1238, contains a copy of the vetoed act. A third enabling act was passed the following January by this same Congress, and was likewise vetoed by the President. The second veto message, Sen. Ex. Doc. 7; 39C.2; Serial 1277, contains elaborate reasons for the veto, the chief ground being the small population of the territory, its recent shrinkage in numbers, and the injustice of such admission to the older states.

While the statehood agitation was in progress, the territory suffered from constant Indian attacks. Incidental to these attacks are the investigation into the Indian finances of Governor A. B. Cummings, H. Misc. Doc. 81; 39C.2; Serial 1302, and the statement of the expenses of the First Colorado Regiment in a campaign of 1865, H. Ex. Doc. 7; 40C.2; Serial 1330.

The interest of Congress in the territory and its Indian troubles is followed by the beginning of popular curiosity as to the new country. Among the articles which cater to this demand are two which are found in *Harper's Magazine* for June and July, 1867. In the latter issue, Vol. XXXV, pp. 137–150, there is an account of the trip across the plains by F. R. Davis, entitled "A Stage Ride to Colorado." The life of the pioneer emigrant is described in this account of a journey by the Smoky Hill route from Omaha to Denver. Some interesting statements are made as to the condition of the railroad end of the route. A month earlier than the account of Davis, A. W. Hoyt has in the same magazine, Vol. XXXV, pp. 1–21, a brief description of a similar trip "Over the Plains to Colorado," of which the more impor-

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tant part consists of a description of the mining camps then existing in the territory.

Greeley, settled in 1869, is remarkable among frontier communities in that it was deliberately planted in lands which could easily be put under ditch. The village from the start was occupied by an eminently moral and temperate population, under the leadership of Meeker, and under the countenance of Horace Greeley. Its resulting prosperity is described by Richard T. Ely in "The Story of a 'Decreed' Town," in *Harper's Magazine*, Vol. CVI, pp. 390–401, February, 1903.

The census of 1870 gave some support to the contention of President Johnson, since it reported a population of only 39,841 for the territory. But the figures were attacked by the settlers in Colorado. There is to be found in Sen. Misc. Doc. 40; 41C.3; Serial 1442, a statement signed by territorial governor McCook, which denies the accuracy of the census. It gives various tables showing taxable values, agricultural statistics, railway growth, etc., and closes with an inaccurate abstract of the legislative history of the statehood movement. The early years of the seventies saw considerable settlement in the territory, and twice between 1870 and 1875 did the House Committee on Territories report in favor of the admission of Colorado. The former report is in H. Rep. 8; 42C.3; Serial 1576, dated January 6, 1873. The second comes May 28, 1874, in H. Rep. 619; 43C.1; Serial 1626. This latter report, by Chaffee, gives valuable figures as to the condition of the territory, based on a census of 1873. Its figures of railways are specially interesting.

Colorado became a state in 1876, and the framing of its constitution is the subject of an article by E. H. Meyer in the *Iowa Journal of History and Politics* for April, 1904, Vol. II, pp. 256–274, with the title "The Constitution of Colorado." The admission of the state was by presidential proclamation, in accordance with an act passed at the end of the Forty-third Congress. In the following Congress the point was raised as to the constitutionality of this method of admission, and the House Committee on Judiciary presented majority and minority reports to the house upon the propriety of seating James W. Belford as representative from Colorado without further legislation, H. Rep.

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67; 44C.2; Serial 1769; pp. 24. The majority report advised the seating of the delegate, while both reports went into the details of the territorial policy of the United States.

The admission of the new state brought into a new prominence the problem of the military control of the Southwest, with the result that exploration and survey of new routes advanced rapidly. The lines of communication between southern Colorado and points in Arizona and New Mexico inspired a report from the Secretary of War on March 31, 1876, H. Ex. Doc. 172; 44C.1; Serial 1691; pp. 34. The next Congress saw a similar report on communication between Colorado and New Mexico, based upon a reconnaissance of the San Juan country in 1877, H. Ex. Doc. 66; 45C.2; Serial 1806; pp. 38. This report includes three maps, one of which shows the outlines of the Ute Indian reservation at the time. And another map, published in a report of the same department in May, 1878, H. Ex. Doc. 88; 45C.2; Serial 1809, shows all the surveys and explorations made west of the hundredth meridian during the ten years then ending.

The earliest prominence of Colorado in the magazines came with the discovery of the large deposits of silver in and near Leadville, about 1877. Before these discoveries, the federal surveys had inspired a description of the work of the "Wheeler Expedition in Southern Colorado," by W. H. Rideing, in *Harper's Magazine*, Vol. LII, pp. 793–806, May, 1876. But this account of a party which started from Pueblo and crossed to the southwest in search of wagon routes, is exceptional, and it is not until about 1880 that a real interest is aroused. The new Leadville camp drew visitors from all the United States, and among them was Helen Hunt Jackson, who then lived in Colorado Springs, and told of her trip "To Leadville" in the *Atlantic Monthly* for May, 1879, Vol. XLIII, pp. 567–579. This, like other articles from the same pen, is light and discursive, valuable not for its contribution to facts, but for its contribution to color. E. Ingersoll's "Camp of the Carbonates," in *Scribner's Monthly* for October, 1879, Vol. XVIII, pp. 801–824, is more serious than Mrs. Jackson's article, and gives some useful accounts of definite conditions in Leadville. "Grub Stakes and Millions," by A. A. Hayes, in *Harper's Magazine*, for Febru-

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ary, 1880, Vol. LX, pp. 380–397, is of similar character. More serious than any of these is an article on "Colorado" which appeared in the *Fortnightly Review* for January, 1880, Vol. XXXIII, o. s., pp. 119–129, over the name of J. W. Barclay. Here, prepared for an English public, is an account of the conditions prevailing throughout the state, with special and conservative reference to the possibilities of the state in mining, agriculture, and grazing; while the appeal of the mountains to the hunter and sportsman is sounded by the Earl of Dunraven in the *Nineteenth Century* for September, 1880, Vol. VIII, pp. 445–457, with the title "A Colorado Sketch."

The silver interests are not the only ones which attracted the visitor about 1880. A. A. Hayes described "The Cattle Ranches of Colorado" in *Harper's Magazine* for November, 1879, Vol. LIX, pp. 877–895. The grazing possibilities of the Arkansas valley are exploited in this paper, while its general argument is carried a step further by the same author in *Harper's* for January, 1880. Vol. LX, pp. 193–210, with the similar title, "Shepherds of Colorado," and his "Vacation Aspects of Colorado" found place in the issue for May, Vol. LX, pp. 542–556. The same year which saw these articles of Hayes saw further papers from Mrs. Jackson, who journeyed out from her home in Colorado Springs to various points of interest, and continued to write little discursive sketches of camps and scenery and people. Her "A New Anvil Chorus," in *Scribner's Monthly* for January, 1878, Vol. XV, pp. 386–395, tells of a visit to Fort Garland and the San Juan valley, of racial types and railway construction; "Little Rose and the House of the Snowy Range," in the same monthly for May, 1878, Vol. XVI, pp. 55–58, carries her to the Sangre di Cristo range and the Wet Mountain valley; and finally she contributed to the *Atlantic*, in December, 1883, Vol. LII, pp. 753–762, an account of her trip to Crested Butte and the Gunnison fields of 1880, with the title "O-Be-Joyful Creek and Poverty Gulch."

Parallel to the mining interest of the Leadville boom came a desire to explore the lands of the southwestern part of Colorado, and a demand that the Ute Indians be removed from the state by the federal government. The Secretary of War replied to a resolution of the House

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with a message of May 23, 1878, H. Ex. Doc. 91; 45C.2; Serial 1809; pp. 4, in which he described the means taken for the protection of residents of western Colorado and gave a map showing parts of the Ute reservation, with the portion in dispute in the Uncompahgre country. As a result of this pressure the removal was provided for by Congress, and the lands in question were ceded by the Utes June 15, 1880. A letter to the Commissioner of Indian Affairs tells of the condition of the Indians to be removed, H. Misc. Doc. 57; 45C.2; Serial 1820; pp. 5; while after the bill had been passed, the Committee on Public Lands, through T. M. Patterson, advocated the survey of the boundary between Colorado and New Mexico, on the ground that the mineral deposits in the new territory made such a survey necessary, H. Rep. 708; 45C.2; Serial 1825. Four years later, the removal having been accomplished, on August 28, 1881, the Committee on Public Lands again brought up the matter of the Ute agreement, and asked for legislation to protect the settlers in their titles in the old reservation, its boundaries not having been surveyed, and the land itself not yet having become a part of the public lands, H. Rep. 561; 47C.1; Serial 2066. The same report, with slight verbal changes, is found also in Sen. Rep. 186; 47C.1; Serial 2004. The question of titles in these lands was long a matter of confusion, a homestead bill for them being considered in 1902, and advocated by Shafroth of Colorado, H. Rep. 1275; 57C.1; Serial 4403.

The decade of the eighties is one of rapid development in all directions, bringing as a by-product many difficult questions concerning the administration of the public lands. The common occurrence of agricultural school lands turning out to be mineral lands produced in 1880 a report from the Committee on Public Lands, Sen. Rep. 256; 46C.2; Serial 1893, and another in 1898, H. Rep. 792; 55C.2; Serial 3719. Similarly, the confusion among the railway land grants to the Union Pacific and the Denver Pacific Railways is responsible for a bill introduced to protect purchasers of such lands in their titles, H. Rep. 2846; 50C.1; Serial 2605. All of the agricultural lands received a new value as irrigation progressed. The proposal to lease the arid lands of Colorado evoked in 1882 majority and minority reports from

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the Committee on Public lands, H. Rep. 197; 47C.1; Serial 1065. The Secretary of the Interior made an estimate in 1889, the year after the formal irrigation survey had begun under the Geological Survey, of the irrigation capacities of the Platte and Arkansas valleys, Sen. Ex. Doc. 120; 50C.2; Serial 2612, in response to a call from the Senate; and the House Committee on Public Lands, in the same session, recommended the establishment of three new land offices in Colorado, to meet the demands of increasing sales, H. Rep. 3617; 50C.2; Serial 2673. The establishment of forest reserves created complications in mining lands, a bill to open such reservations to mining claims receiving in 1896 favorable reports from both of the committees, Sen. Rep. 191; 54C.1; Serial 3362, and H. Rep. 152; 54C.1; Serial 3457.

The early nineties saw a considerable degree of interest in Colorado, inspired by the great discoveries at Cripple Creek, and the prominent part played by the great discoveries at Cripple Creek, and the prominent part played by the state in the prevailing monetary discussions. The general question of mining and mining education came in for consideration, and the latter extracted from the House Committee on Mines and Mining a recommendation that a portion of the proceeds from the sale of public lands should be turned over to the aid of the School of Mines in the state in which the lands were sold, H. Rep. 1136; 51C.1; Serial 2810. The *Nation* on October 5, 1893, Vol. LVII, pp. 245–246, gave space to a geographical and romantic description of "Pike's Peak and Colorado Springs" by Mabel L. Todd; and *Harper's Magazine* for May of that year had already printed, Vol. LXXXVI, pp. 935–948, a description by the New York correspondent of the *London Times*, Julian Ralph, of "Colorado and its Capital." More specific accounts of the mining excitement of this year are Cy Warman's "Story of Cripple Creek," in the *American Review of Reviews* for February, 1896, Vol. XIII, pp. 161–166, with its description of the early rush into the camp and the resulting construction of railways; and his similar article in the *Colorado Magazine*, Vol. I, pp. 67–76, April, 1893. Warman had already contributed to the *Colorado Magazine*, Vol. I, pp. 163–172, May, 1893, an article on "Crede," describing the discovery of the Amethyst vein in 1891, the

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extension of the Denver & Rio Grande tracks to the camps in the autumn of that year, and the resulting fortunes for Crede, the discoverer, and Moffat, his partner. A little later, Francis Lynde published in *Scribner's Magazine*, which is to be distinguished from the earlier *Scribner's Monthly*, a narrative description of "Cripple Creek" in the issue for May, 1900, Vol. XXVII, pp. 603–616. And, finally, the *Colorado College Studies*, General Series, No. 17, June, 1905, pp. 1–48, presents a paper on "The Cripple Creek Strike of 1893," by B. M. Rastall, with an introduction by Professor T. K. Urdahl.

On the monetary situation there are magazine articles without number, only a few calling for mention here. In September, 1893, when the question of silver had come into existence, the *Review of Reviews* presented a friendly account of "The Silver Situation in Colorado," Vol. VIII, pp. 276–280, by E. W. Bemis, of the University of Chicago. The *North American Review* brought out in January, 1894, Vol. CLVIII, pp. 24–29, an article by the new Populist governor of Colorado, Davis H. Waite, on "Are the Silver States Ruined?" and in its next number, February, 1894, Vol. CLVIII, pp. 247–249, allowed J. E. Leet to reply to Governor Waite with "Colorado's Bright Outlook". The "Situation in Colorado" was again discussed in May, 1896, in the *Yale Review*, Vol. V, pp. 50–57, by L. R. Ehrich, who saw the manner in which gold production was gaining upon silver, and changing the financial balance of the state.

The struggle for women's suffrage in Colorado began long before the admission of the state, but became successful only during the Populist period in 1893. James H. LeRossignol, in the *Annals of the American Academy of Political and Social Science*, Vol. XVIII, pp. 552–556, has a brief article on "Woman's Suffrage and Municipal Politics," with a useful bibliography. Later, Elizabeth McCracken contributed to the *Outlook*, Vol. LXXV, pp. 737–744, November, 28, 1903, in her series "The Women of America," a distinctly witty and unfriendly statement upon the workings of "Women's Suffrage in Colorado," which evoked from Mary G. Slocum, wife of the president of Colorado College, an indignant, but dignified, refutation in the *Outlook*, Vol. LXXV, pp. 997–1000, December 26, 1903. Women's

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suffrage, like the silver question, cannot receive more than a suggestive bibliography in this place.

In an international way Colorado provoked remonstrance from Baron Fava, the Italian minister, and from Secretary of State Olney, when certain Italian subjects were lynched in Walsenberg in March 1895. The lynching arose out of a murder of an American saloonkeeper named Hixon, and became the occasion of an extensive correspondence between the United States, Italy, and Governor McIntire of Colorado, parts of which are printed in H. Doc. 195; 54C.1; Serial 3420, pp. 20. Six years later a mob destroyed a fish hatchery belonging to one William Radcliffe, a British subject, at Delta, and again the intervention of the federal government was provoked. In this case President Roosevelt, in a message of March 14, 1904, recommended an indemnity of $25,000 to the victim, and transmitted the documents in the case to Congress, Sen. Doc. 271; 58C.2; Serial 4592; pp. 40.

Of slight importance in the history of Colorado, but of some consequence in its sociological aspect, is the attempt of the Salvation Army to found and conduct a community at Fort Amity, Colorado. Because of an alleged inability of this body to pay promptly for the arid lands purchased from the United States and irrigated by the settlers, it is the occasion of a number of public documents, especially H. Rep. 364; 56C.1; Serial 4022; February, 1900, Sen. Rep. 1135; 56C.1; Serial 3894; May, 1900, and Sen. Rep. 2950; 57C.2; Serial 4412; February, 1903. All of these documents are very brief, but they give some notion of the scope and activity of this type of poor-relief. The journalistic reports of the same settlement, as in "Making Successful Farmers out of City Failures," in *World's Work*, Vol. VI, pp. 3929–3930, and in the *Outlook*, Vol. LXXIV, pp. 640–641, show much success at Amity, and require some reconciliation with the statements of the public documents.

Miscellaneous items of Coloradoana in the middle nineties are a favorable report on a pipe-line bill for Colorado and Wyoming, H. Rep. 1563; 54C.1; Serial 3462; a report favoring the grant to Colorado of the abandoned Fort Lyons military reservation for a sol-

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diers' and sailors' home, H. Rep. 1847; 54C.1; Serial 3464, and another, on granting to the Cripple Creek District Railway Company a right of way through the Pike's Peak timber land reserve, H. Rep. 1592; 55C.2; Serial 3722. About 1900 came Shafroth's report on the preservation of pre-historic ruins in Colorado, H. Rep. 1104; 56C.1; Serial 4025; Hansbrough's recommendation of permission to Montrose to enter 160 acres of public lands for reservoir purposes, Sen. Rep. 2955; 57C.2; Serial 4412; and Palmer's report recommending the erection of terms of federal circuit and district courts at Montrose in place of Del Norte, H. Rep. 3378; 57C.2; Serial 4414. Finally, there is in 1901 a long report of a committee named by the General Assembly of Colorado, on the Australasian system of taxation and the revenues of Colorado, Sen. Doc. 209; 56C.2; Serial 4043; pp. 36. The *Outlook* during these same years calls attention to the sociological work under Dr. R. W. Corwin of the Colorado Fuel and Iron Company, Vol. LXXII, pp. 149–150; to the "Religious Life in Colorado," Vol. LXXII, pp. 365–371 to the home-rule charter of Denver, Vol. LXXV, p. 97, and to the franchise amendment Vol. LXXVI, pp. 249–250.

The great mining strike of 1903–1904 caused much attention to be given to industrial and constitutional conditions in Colorado. Beginning with the sympathetic strike of the Cripple Creek miners in August, and continuing through the calling-out of troops, the explosion at the "Vindicator" mine, the recall of troops, the Independence disaster, and the deportations, there is a long series of pertinent articles to be recorded. The *Outlook*, Vol. LXXV, p. 390, October 17, 1903, comments upon the beginning of the strike, and its provocation in the eight-hour agitation. In later issues it calls attention to the less important strike of the coal miners, and to the complications produced by the appearance of the Citizens' Alliances, Vol. LXXV, p. 763*; to the general support given by the business interests at Cripple Creek to the drastic measures of Governor Peabody, Vol. LXXVI, pp. 143–144; and to the dangerous social cleavage which divided the mining communities into the hostile Mine Owners' Association and the Western Federation of Miners, Vol. LXXVI, pp. 1001–1003. As the spring

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of 1904 advanced, *Current Literature*, Vol. XXXVI, pp. 482–484, called attention to the attempt at an ending of martial law while "G," writing to the *Outlook*, Vol. LXXVII, pp. 21*–22,* commented upon the arbitrary assumption of powers as well by the state authorities as by the leaders of the Western Federation. The terrible disaster at Independence station produced paragraphs in the *Outlook*, Vol. LXXVII, pp. 384–385, and in *Current Literature*, Vol. XXXVII, pp. 3–5. The deportations of miners following close upon this disaster created what *Current Literature* Vol. XXXVII, pp. 104–106, characterized as a "carnival of crime," in which, Vol. XXXVI, pp. 594–596, both sides were largely to blame—a conclusion with which the *Outlook*, Vol. LXXVII, pp. 394–396, agreed. *Current Literature* suggested a little later, Vol. XXXVII, pp. 303–305, the possibility of federal intervention in Colorado. A socialistic view of the strike is to be found in *Wiltshire's Magazine*, May, 1904, pp. 219–224, by Henry O. Morris, under the title "The Conspiracy against Labor in Colorado." It is accompanied by editorials on the "Mine Owners' Infamous Purpose." On the other side is "The Supremacy of Law," by William M. Raine, in the *Reader Magazine*, Vol. IV, pp. 399–409, September, 1904. These paragraphs and editorials by no means comprise the whole output upon the strike. All the weekly papers give some attention to it.

The proportions which the strike came to assume in its constitutional bearings ultimately produced three important missions to Colorado. The brilliant report of Ray Stannard Baker on "The Reign of Lawlessness, Anarchy, and Crime in Colorado" appears in *McClure's Magazine*, Vol. XXIII, pp. 43–57, May, 1904. The Rev. Washington Gladden made a similiar report for a syndicate of newspapers beginning with the *Columbus Press Post*, and appearing, among others, in the *Denver Times*, for April 22 and 23, 1904. It is worthy of note that the *Denver Republican* did not consider these letters worthy of any considerable mention. The third special report was by William English Walling, a resident of the New York University Settlement, and appeared in the *Independent*, Vol. LVI, pp. 539–548, March 10, 1904, with the title "The Great Cripple Creek Strike."

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In Congress the political aspect of the strike had its result in three documents which are of high value as sources for the history of 1903–1904. A statement of the employers' side, prepared by C. C. Hamlin, secretary of the Mine Owners' and Property Owners' Association of Cripple Creek, and at once attacking the Western Federation of Miners and defending the administration of Governor Peabody, was presented to the Senate by Scott, of West Virginia, in January, 1904, Sen. Doc. 86; 58C.2; Serial 4588; pp. 19. It produced later in the same session, a reply from the Western Federation, through Patterson, of Colorado, Sen. Doc. 163, 58C.2; Serial 4590; pp. 41, which denies most of the allegations of the earlier document, and reviews the history of strikes since 1894 in an attempt to throw the responsibility for them upon the owners and employers. It contains many extracts from contemporary newspapers and correspondence, but is far surpassed in completeness by the "Report on Labor Disturbances in Colorado, 1880–1904," made by an agent of the Commissioner of Labor, and printed as Sen. Doc. 122; 58C.3; pp. 363. This document, because of the originals which it prints, and because it is fairly non-political in tone, is the best single source for the history of the labor troubles.

The situation brought forth also an editorial by B. O. Flower, in the *Arena*, Vol. XXXII, pp. 187–194, August, 1904, on the "Breaking Down of Democratic Government in an American Commonwealth," which reviews the special articles on the strike, and develops the initiative and referendum as cure for such ills as those of Colorado. The *Arena*, in the autumn of 1905, ran a series of papers by J. W. Mills on "The Economic Struggle in Colorado," which is a long tract on municipal ownership of corporations.

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ENGLAND AND MEXICO, 1824-1825[1]

By Frederic Logan Paxson

The activities of Great Britain in Mexico during the years 1824 and 1825 were inspired, not only by a desire to ascertain the actual conditions prevailing in that republic, with a view to ultimate recognition, but also by an anxiety lest the United States should profit by proximity and interest, and thereby acquire undue advantages in Mexico. These facts are clearly developed by the Foreign Office correspondence of these years, and the following extracts from the correspondence tell the story, with but little need for comment.

It was with difficulty that Canning preserved in his Mexican agents the neutral attitude which he desired to show to all the Latin-American colonies. The most imperative instructions often failed to direct the actions of the men on the ground. "You are sent," he instructed one of them,[2] "to ascertain the Fact of Mexican Independence, not actively to promote it; and to form and report an Opinion of the Stability of the Government, not to prescribe its form or attempt to influence its Councils." Yet there was a quality in the Mexican influence to which none of his agents was impervious. Whether it was a corrupt attack, or a sympathy with the spirit of independence, or a truer view based upon better information, is hard to say; but certain it is that the English agents cannot be accused of failing to see certain dangers taking shape along the northern frontier, or of failing to try to inspire both Mexico and the Foreign Office to resist them.

As early as January, 1824, the agent, Lionel Hervey, had announced to Canning that Mexico was ready to enter into exclusive trade arrangements with Great Britain, and had advised strongly in favor of such an arrangement. Spain had been expelled, he said, and Mexico was too poor and too weak to stand alone. "Hence the Mexicans are looking anxiously around them in quest of an Alliance with one of the

[1] Reprinted from the *Quarterly of the Texas State Historical Association*, October, 1905, Vol. IX, pp. 138–141.

[2] Canning to Morier, July 30, 1824, *Foreign Office MSS.*

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great Maritime Powers of Europe, and if they should be disappointed in their hopes, they will ultimately be forced to throw themselves into the arms of the United States, already opened wide to receive them."[1]

In particular, the danger arising from the American colonization of Texas, then in progress, was realized by the English agents. Hervey, in the dispatch already mentioned, called attention to the introduction of American capital, and to the building of American roads, as well as to the immigration of American citizens. And Ward, the chargé who succeeded him, repeated his cries of warning. On the 1st of June, 1825, the latter assisted[2] "at the reception of Mr. Poinsett, who has presented his credentials as Envoy Extraordinary, and Minister Plenipotentiary, from the United States," and was particularly impressed by "the length of Mr. Poinsett's speech, which occupied near a quarter of an hour. After paying the highest compliments to General Victoria, to whose courage and constancy, Mr. Poinsett attributed the present prosperous state of Mexico, he congratulated the Mexicans in general upon the choice which they had made of a republican form of Government, which, he said, was most particularly agreeable to the President and citizens of the United States. He spoke in the most flattering terms of the manner in which the struggle for Independence had been conducted, and added that it was to the great qualities which had been displayed in the course of this struggle that they must attribute the justice which was now done them by the *first* nation of the Old World, and the nation, which had *first* sown the seeds of liberty in the New.

"Mr. Poinsett concluded by giving an analysis of the object of his mission, which, he said was to conclude a Treaty of Commerce, and Boundaries—an intimation, which appeared, by no means so palatable as the preceding part of his speech, if one might judge by the looks of the Spectators, who were well aware of the difficulties with which the question of boundaries is likely to be attended.

"General Victoria's reply was very concise, but as I expect to be able to enclose a translation of it, I do not think it necessary to trouble you with any details upon the subject here."

[1] Hervey to Canning, January 18, 1824, *Foreign Office MSS.*, Mexico, VI.

[2] Ward to Canning, June 1, 1825, *Foreign Office MSS.*, Mexico, XIII.

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The relations between Ward and Poinsett during the summer of 1825, and after, would make an interesting study, and one for which materials lie ready to the hand of the worker. In the manuscripts of the Foreign Office are preserved the original letters of the British agent, while the fourteen folio volumes of the papers of Joel R. Poinsett which are in the library of the Historical Society of Pennsylvania have hardly been even touched. Yet in these papers is to be found the detailed story of the struggle between British and American influence in Mexico. Both of the competitors emerged from the contest with high opinions of the abilities of their respective opponents.

During the struggle of 1825 the British agent became further convinced of the inevitable conflict between Mexico and the United States along the Rio Grande, and his despatches are truer than most historical prophecies.

"The treaty," he writes to Canning, on the 6th of September, 1825,[1] "between the United States and this country, advances but slowly, though I am at a loss to understand, in what the cause of the delay consists . . . . while the Mexicans are . . . . jealous in guarding against encroachments in the shape of a treaty, they are suffering, on the other hand, by an absurd mixture of negligence, & weakness, the whole disputed territory, and an immense tract of country beyond it, to be quietly taken possession of by the very men, whose claim to it, they are resisting here:—you will perceive Sir, by a reference to the Map, that the whole of the lands between the rivers Sabine and Brazos, have been granted away to American Settlers, and that the tide of emigration is settling very fast in the direction of the Rio Bravo. These grants have been made by the provincial Government of Texas, and retailed by the Original speculators to the hordes of their countrymen, which have already arrived there, at a moderate price of half a dollar an acre, by which however they have cleared 150 per cent. profit. On the most moderate computation, six hundred North American families are already established in Texas; their numbers are increasing daily, and though they nominally recognize the authority of the Mexican Government, a very little time will enable them, to set at

[1] Ward to Canning, September 6, 1825, *Foreign Office MSS.*, Mexico, XIV.

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defiance any attempt to enforce it. . . . . General Wavell has, I believe, a considerable share, [of the land] but he is, I understand, almost the only Englishman, who has applied for land in Texas. The rest of the settlers are all American—Backwoodsmen, a bold and hardy race, but likely to prove bad subjects, and most inconvenient neighbors. In the event of a rupture between this country and the United States, their feelings and earlier connections will naturally lead them to side with the latter; and in time of peace their lawless habits, and dislike of all restraints, will, as naturally, induce them to take advantage of their position which is admirably adapted for a great smuggling trade, and to resist all attempts to repress it. In short, Mexico, though she may gain in point of numbers, will not, certainly, acquire any real strength, by such an addition to her population. . . . . Not knowing in how far His Majesty's Government may conceive the possession of Texas by the Americans, to be likely to affect the interests of Great Britain, I have not thought it right to go beyond such general observations upon the subject, in my communications with this Government, as appeared to me calculated to make it perceive the danger, to which it is wilfully exposing itself. Were but one hundredth part of the attention paid to practical encroachment, which will be bestowed upon anything like a verbal cession, Mexico would have little to fear."

There is reason to believe, from this correspondence, that the tendencies of the western movement in Texas were recognized by England before even the settlers realized that which was coming to pass.

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"For even as children are flurried and dread all things in the thick darkness, thus we in the dayli t fear at times things not a whit more to be dreaded than those which children shudder at in the dark and fancy sure to be. This terror, therefore, and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and law of nature."—*De Rerum Natura*, II, 55–61.

"The older view of idealistic dualism is breaking up with all its mystic and anthropistic dogmas; but upon the vast field of ruins rises, majestic and brilliant, the new sun of our realistic monism, which reveals to us the wonderful temple of nature in all its beauty."—*Welträthsel*, 381–82.

"Lucretius, even in the Judgment of the Antients is both a very great Poet and Philosopher, but full of Lies: for having follow'd the Epicurean Sect, his opinions concerning God, and of the Creation of Things, are quite different from the Doctrine of Plato, and of the other Academicks; for which Reason some believe that he ought not to be read by Christians, who adore and worship the true God. But since Truth the more it is inquir'd into, shines the more bright, and appears the more venerable, Lucretius, and all that are like Lucretius, even tho' they be Lyars, as they certainly are, ought in my opinion to be read."—*Aldus Pius* in a letter to Albertus Pius.

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LUCRETIUS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE

By Fred B. R. Hellems

Part I. The Immortality of the Soul[1]

That there are striking coincidences in the theories of Lucretius and of Haeckel has been frequently stated and much more frequently felt. It is clear, however, that many thorough-going admirers of the great German monist, as well as most of his opponents, whether honest or captious, have contented themselves with a vague knowledge of the resemblance between the two men without recalling the number and nature of the detailed parallels. Classical men, too, I fear, have been satisfied to enjoy the golden verse of him who "died chief poet on the Tiber-side" without correlating his views to modern monistic theories. Accordingly, having seen no adequate comparison, in a purely academic spirit, of the solutions of the *Welträthsel* proposed by Lucretius and Haeckel and the arguments thereto appurtenant, I have conceived the hope of setting them forth with some clearness and accuracy in the present paper. My object will be to compare or contrast the views of these kindred spirits, without making any systematic attempt to evaluate the conclusions they have reached. Furthermore, there is no desire on my part to emphasize Haeckel's indebtedness to Lucretius. The writer of the *Welträthsel*, who speaks most cordially of the "grosse römische Dichter und Naturphilosoph," would be the first to acknowledge whatever indebtedness there may be, and in any case it is inevitable that the representative of the latest stages of monistic thought should bear many traces of the journey through which that thought has reached its present inn. It is true that we shall find more and closer resemblances to Lucretius than we had expected; but, after all, the step from the Tiber of two thousand years ago to the Rhine of to-day is short indeed compared with

[1] Part II, dealing with the remaining riddles, will appear in the next number of the "Studies."

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the flight beyond the "flammantia moenia mundi" in the infinities of time and space with which these master-minds are ultimately concerned.[1]

The larger kinship of spirit between the author of the *De Rerum Natura* and the author of the *Welträthsel* is stamped upon their works from the very beginning, for both men announce their firm belief that the great and pressing evils of our political, social, and moral worlds are to be met only by the development of clear views as to man, and his relations to life and death and the universe.[2] More striking is the appearance so early in their books of the arraignment of religion as responsible for many of the greatest evils.[3] Correspondingly early is given the general solution for the problems, and our authors are thoroughly at one in the belief that if you can shed the light of nature and nature's law into the human mind to replace the blindness of ignorance and the terror of superstition, you will have a better moral life as inevitably as the day follows the night. Through the exposition of both men there run—forming, as it were, a master motive—the words "law" and "reason." Neither could be more insistent than the other upon a "doctrine of law and steadfast universal order in nature" operating from the least conceivable particle of matter to the utmost bounds of the universe and the highest development of the human mind. Just as applicable to the *De Rerum Natura* as to the

[1] Lucretius will be considered as the representative of monistic or materialistic philosophy as developed by the middle of the first century B. C., and no distinction will be made between his own contributions and what he accepted from his predecessors, such as Democritus, Empedocles, and Epicurus. As representing Haeckel's message on these subjects put in accessible form for the general reader, the *Welträthsel* will be followed throughout. For convenience quotations will be made from the English edition of the *Welträthsel* (Harper and Brothers, 1901), and the translation of Lucretius by Munro. (Deighton Bell & Co., 1891.)

[2] *WR.*, chap. 1, *et al.*; *De R. N.*, I, 107–109, 127–135, 146–148, *et al.*

[3] To understand the sternness, or even ferocity, of their attitude towards religion, one may compare these passages: "Of all the wars which nations have waged against each other with fire and sword the religious wars have been the bloodiest; of all the forms of discord that have shattered the happiness of families and of individuals, those that arise from religious differences are still the most painful. Think of the millions who have lost their lives in Christian persecutions, in the religious conflicts of Islam and of the Reformation, by the Inquisition, and under the charge of witchcraft."—*WR.*, p. 303, cf. 318–319. "This is what I fear herein, lest haply you should fancy that you are entering on unholy grounds of reason and treading the path of sin; whereas on the contrary often and often that very religion has given birth to sinful and unholy deeds." Then he instances the sacrifice of Iphigenia before the departure of the Greek fleet for the Troad. "Nor aught in such a moment could it avail the luckless girl that she had first bestowed the name of father upon the king. For lifted up in the hands of men she was carried shivering to the altars, not after due performance of the customary rites to be escorted by the clear-ringing bridal song, but in the very season of marriage, stainless maid mid the stain of blood, to fall a sad victim by the sacrificing stroke of a father, that thus a happy and prosperous departure might be granted to the fleet. So great the evils to which religion could prompt."—*De R. N.*, I, 80–101.

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Welträthsel are Goethe's lines,[1] with which Haeckel concludes his work:

Nach ewigen, ehernen
Grossen Gesetzen
Müssen wir alle
Unseres Daseins
Kreise vollenden.

But this scientific spirit with its insistence on law and reason does not prevent the kindling in their breasts of a missionary zeal for the salvation of a lost world. Though they argue never so formally and dispassionately, both of their beings are at a white heat of enthusiasm for the evangel of science. Never prophet or martyr was surer of his vision or of its redeeming value to frail humanity than these two representatives of what most people call materialism. "Come unto us and we will set you free," is the eager cry on their apostolic lips; "with us you may find, not the mystic peace that passeth understanding, but the unconquerable peace that only understanding can bestow."

General resemblances, however, are never very hard to find, and we may now turn to our particular riddles, treating them with all possible brevity, and resisting the temptation to stray either into other fields of resemblance or into the more exhaustive treatises of Haeckel. The seven quoted by Haeckel from Emil duBois-Reymond are: (1) the nature of matter and force; (2) the origin of motion; (3) the origin of life; (4) the (apparently preordained) orderly arrangement of nature; (5) the origin of simple sensation and consciousness; (6) rational thought and the origin of the cognate faculty, speech; (7) the question of the freedom of the will. To these we may add two of Kant's postulates, the third being No. 7 above, and we shall have: (8) the existence of God; (9) the immortality of the soul. Of course, Haeckel classes these last three as mere dogmas, but in his discussions they have quite as much prominence as in Lucretius.

Accordingly, we may take up at once the central question, the

[1] I have never seen the lines adequately translated. The English edition gives the accepted rendering:

"By eternal laws
Of iron ruled,
Must all fulfil
The cycle of
Their destiny."

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immortality of the soul. As a starting-point for our discussion thereof we should have before us the conception of the soul that our writers unite in combating, and we may quote it from Haeckel: "The prevailing conception of the psychic activity, which we contest, considers soul and body to be two distinct entities. These two entities can exist independently of each other; there is no intrinsic necessity for their union. The organized body is a mortal, material nature, chemically composed of living protoplasm and its compounds. The soul, on the other hand, is an immortal, immaterial being, a spiritual agent whose activity is entirely incomprehensible to us."[1] To this conception our authors are radically opposed. They both hold that the soul has no existence apart from the body, and is therefore mortal. They differ from each other in that Haeckel regards the soul as merely a psychic activity, while Lucretius in his excessive refining thinks of it as an entity within the body. This difference, however, may be practically neglected when you read the reiterated statement of Lucretius that "the mind and soul are kept together and make up a single nature."[2] "Do you mind to link to one name both of them alike; and when, for instance, I shall choose to speak of the soul, showing it to be mortal, believe that I speak of the mind as well, inasmuch as both make up one thing and are one united substance?"[3] Both insist that all psychic activities, like all other phenomena, have a material basis. By Haeckel this is called psychoplasm—"a body of the group we call protoplasmic bodies, the albuminoid carbon combinations, which are at the root of all vital processes."[4] By Lucretius it is said to be "seeds exceedingly round and exceedingly minute in order to be stirred and set in motion by a small moving power."[5] It is hardly necessary to point out that this divergence is a matter of chemical and physiological advance rather than a real difference of position.

With this statement of their general conception of the soul before us we shall easily understand their attitude and arguments, and it

[1] *WR.*, 89–90.
[2] *De R. N.*, III, 136–137.
[3] *De R. N.*, III, 421–424.
[4] *WR.*, 90–91.
[5] *De R. N.*, III, 186–188. We need not concern ourselves with his rather metaphysical attempt to subdivide this nature. (See III, 231 *seq.*)

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will probably be profitable to take up first four phases of attack which we may conveniently treat as preparatory, although Lucretius does not so distinguish them from the three phases which we shall consider later.

I. Examination of Metempsychosis[1]

Lucretius: "Again if the nature of the soul is immortal and makes its way into our body at the time of birth, why are we unable to remember besides the time already gone, and why do we retain no traces of past actions? If the power of the mind has been so completely changed, that all remembrance of past things is lost, that methinks differs not widely from death; therefore you must admit that the soul which was before has perished and that which now is has been formed."[2]

Haeckel: "As Plato postulated an eternal life before as well as after this temporary association [of body and soul], he must be classed as an adherent of 'metempsychosis' or transmigration of souls; the soul existed as such, or as an 'eternal idea,' before it entered into a human body. When it quits one body it seeks such other as is most suited to its character for its habitation. The souls of bloody tyrants pass into the bodies of wolves and vultures, those of virtuous toilers migrate into the bodies of bees and ants, and so forth. The childish naïveté of this Platonic morality is obvious; on closer examination his views are found to be absolutely incompatible with the scientific truth which we owe to modern anatomy, physiology, histology, and ontogeny; we mention them only because, in spite of their absurdity, they have had a profound influence on thought and culture."[3]

II. Examination of some Theories of Psychogenesis

Lucretius: "Again if the quickened power of the mind is wont to be put into us after our body is fully formed, at the instant of our birth and our crossing the threshold of life, it ought, agreeably to this, to live, not in such a way as to seem to have grown with the body and together with its members within the blood, but as in a den apart by and to itself: the very contrary of what undoubted fact teaches; for

[1] This has been the subject of some of the finest Lucretian poetry, and any reader will be well repaid both poetically and philosophically if he will renew his acquaintance with *De R. N.*, III, 830–870.

[2] *De R. N.*, III, 670–678; *cf.* III, 740–775.

[3] *WR.*, 197. Metempsychosis is again dismissed as a myth by Haeckel on p. 135.

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it is so closely united with the body throughout the veins, flesh, sinews, and bones, that the very teeth have a share of sense; as their aching proves and the sharp twinge of cold water and the crunching of a rough stone, when it has got into them out of bread. Wherefore, again and again I say, we must believe souls to be neither without a birth nor exempted from the law of death; for we must not believe that they could have been so completely united with our bodies, if they found their way into them from without, nor, since they are so closely inwoven with them, does it appear that they can get out unharmed, and unloose themselves unscathed from all the sinews and bones and joints. But if haply you believe that the soul finds its way in from without and is wont to ooze through all our limbs, so much the more it will perish thus blended with the body; for what oozes through another is dissolved, and therefore dies. As food distributed through all the cavities of the body, while it is transmitted into the limbs and the whole frame, is destroyed and furnishes out of itself the matter of another nature, thus the soul and mind though they pass entire into a fresh body, yet in oozing through it are dissolved, whilst there are transmitted, so to say, into the frame through all the cavities those particles of which this nature of mind is formed, which now is sovereign of our body, being born out of that soul which then perished when dispersed through the frame. Wherefore the nature of the soul is seen to be neither without a birthday nor exempt from death."[1]

"Again for souls to stand by at the unions of Venus and the birth-throes of beasts seems to be passing absurd, for them the immortals to wait for mortal limbs in number numberless and struggle with one another in forward rivalry, which shall first and by preference have entrance in; unless haply bargains are struck among the souls on these terms, that whichever in its flight shall first come up, shall first have right of entry, and that they shall make no trial of each other's strength."[2]

All similar views are summarily dismissed by Haeckel as merely "psychogenetic myths worthy only of primitive races." His statement runs as follows:

"*The myth of the inplanting of the soul.*—The soul existed independently in another place, a psychogenetic store, as it were (in a

[1] *De R. N.*, III, 679–712. [2] *De R. N.*, III, 775–783.

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kind of embryonic slumber or latent life); it was taken out by a bird (sometimes represented as an eagle, generally as a white stork), and implanted in the human body.

"*The myth of the creation of the soul.*—God creates the souls, and keeps them stored—sometimes in a pond (living in the form of *plankton*), according to other myths in a tree (where they are conceived as the fruit of a phanerogam); the Creator takes them from the pond or tree, and inserts them in the human germ during the act of conception."[1]

III. As to the Form of the Soul in its Immortal Existence after the Death of the Body

a) That it has a more or less incorporeal, but still material, nature. Haeckel, with a by no means winning flippancy, insists that such an entity is essentially gaseous, and inasmuch as practically all gases have been reduced to liquids, it should be possible to liquefy the soul by the application of a high pressure at low temperature.[2] "We could then catch the soul as it is breathed out at the moment of death, condense and exhibit it in a bottle as 'immortal fluid' (*Fluidum animae immortale*). By a further lowering of temperature and increase of pressure it might be possible to solidify it—to produce 'soul snow.' The experiment has not yet succeeded." Lucretius[3] insists that if the soul is to have a conscious existence—that is, if it can feel—it must be provided with the organs of sense. "Painters therefore and former generations of writers have thus represented souls provided with senses. But neither eyes nor nose nor hand can exist for the soul apart from the body; nor can tongue, nor can ears perceive by the sense of hearing or exist for the soul by themselves apart from the body." That Haeckel also maintains the absolute necessity for material instruments of feeling need only be recalled.

b) That the soul is still clothed with the body it had in life. This conception is dismissed by Haeckel as pure dogma. "The impossibility of 'the resurrection of the body' is clear to every man who

[1] *WR.*, 135.

[2] *WR.*, 199–201. This sort of trifling, conscious as it is, seems to me quite as puerile as the unconscious humor of Lucretius when he thinks that worms generated in our dead bodies may receive their life from some of the "soul-stuff" still remaining therein. *Cf. De R. N.*, III, 713 *seq.*

[3] *De R. N.*, III, 624–633.

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has some knowledge of anatomy and physiology."[1] To Lucretius death is a dissolution of the body once and for all, unless by mere hap the same fortuitous combination of atoms recur in infinite time; but with that combination we should have no concern, for the train of self-consciousness is broken.[2] Our very bodies are needed as material for after-generations to grow, and nature must have the atoms composing our frames. "Thus one thing will never cease to rise out of another, and life is granted to none in fee-simple, to all in usufruct."[3]

c) A purely immaterial soul (for which some thinkers find a certain analogy in recent conceptions of ether in the physical world) neither of our writers could admit any more than the form discussed above under *a*. Haeckel dismisses it formally, Lucretius by implication.[4]

IV. The Argument of "Emotional Craving"

All arguments advanced by athanatists not capable of direct, definite rational treatment, such as the teleological and cosmological, are summarily thrust out by both men; but neither is able to pass in silence the deep-rooted feeling of our human hearts that final separation from those we love is so great an evil that it can not be a part of the order of things. The passages quoted will serve at the same time to make clear the greater dignity and humanity of the olden poet whose strain so often is "fraught too deep with pain." "'Now no more shall thy house admit thee with glad welcome, nor a most virtuous wife and sweet children run to be the first to snatch kisses and touch thy heart with a silent joy. No more mayst thou be prosperous in thy doings, a safeguard to thine own. One disastrous day has taken from thee luckless man in luckless wise all the many prizes of life.' This do men say; but add not thereto 'and now no longer does any craving for these things beset thee withal.' For if they could rightly perceive this in thought and follow up the thought in words, they would release themselves from great distress and apprehension of mind. 'Thou, even as now thou art, sunk in the sleep of death, shalt continue so to be all time to come, freed from all distressful pains; but we with a sorrow that would not be sated wept for thee, when,

[1] *WR.*, 196.
[2] *De R. N.* III, 847 *seq.*
[3] *De R. N.*, III, 964 *seq.*
[4] *WR.*, 199–200.

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close by, thou didst turn to ashes on thy appalling funeral pile, and no length of days shall pluck from our hearts our ever-during grief.' This question therefore should be asked of this speaker, what there is in it so passing bitter, if it come in the end to sleep and rest, that any one should pine in never-ending sorrow."[1]

In Haeckel we read: "The best and most plausible ground for athanatism is found in the hope that immortality will reunite us to the beloved friends who have been prematurely taken from us by some grim mischance. But even this supposed good fortune proves to be an illusion on closer inquiry; and in any case it would be greatly marred by the prospect of meeting the less agreeable acquaintances and the enemies who have troubled our existence here below. There are plenty of men who would gladly sacrifice all the glories of Paradise if it meant the eternal companionship of their 'better half' and their mother-in-law. It is more than questionable whether Henry the Eighth would like the prospect of living eternally with his six wives; or Augustus the Strong of Poland, who had a hundred mistresses and three hundred and fifty-two children."[2]

If we turn now to the more direct arguments against the immortality of the soul, we shall find an even more obtrusive agreement in their main features.

I. The Physiological Argument

If the soul consists of very minute atoms contained within the mortal vessel of this body, and that body be destroyed, the soul will dissolve into its first bodies much more quickly than water will flow from a shattered vase, or than mist and smoke pass into air.[3] Similarly, if your psychic activity depends on "albuminoid carbon combinations," it will cease with the dissolution of these combinations by the death of the body.[4] This phase could be enlarged upon; but, although it is fundamental, it is so simple as to need no further statement here.[5]

II. The Ontogenetic Argument

Lucretius: "Again we perceive that the mind is begotten along with the body and grows up together with it and becomes old along

[1] *De R. N.*, III, 894–911.
[2] *WR.*, 208.
[3] *De R. N.*, III, 426–444.
[4] *WR.*, 91.
[5] See p. 124 of this article.

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with it. For, even as children go about with a tottering and weakly body, so slender sagacity of mind follows along with it; then when their life has reached the maturity of confirmed strength, the judgment too is greater and the power of mind more developed. Afterwards when the body has been shattered by the mastering might of time and the frame has drooped with the forces dulled, then the intellect halts, the tongue dotes, the mind gives way, all faculties fail and are found wanting at the same time. It naturally follows then that the whole nature of the soul is dissolved, like smoke, into the high air; since we see it is begotten along with the body and grows up along with it, and, as I have shown, breaks down at the same time, worn out with age."[1]

Haeckel: "The ontogenetic argument puts before us the facts of the development of the soul in the individual; we see how the child-soul gradually unfolds its various powers; the youth presents them in full bloom, the mature man shows their ripe fruit; in old age we see the gradual decay of psychic powers, corresponding to the degeneration of the brain."[2] Inasmuch as the full significance of this sentence is rather more easily grasped in connection with Haeckel's chapter on consciousness, I append in a note the passage of which this is really a summary.[3] A driving-home of this ontogenetic argument by Haeckel in another place belongs as naturally to Lucretius,

[1] *De R. N.*, 445–458. [2] *WR.*, 204.

[3] *WR.*, 185–186: "As everybody knows, the new-born infant has no consciousness. Preyer has shown that it is only developed after the child has begun to speak; for a long time it speaks of itself in the third person. In the important moment when it first pronounces the word 'I,' when the feeling of self becomes clear, we have the beginning of self-consciousness, and of the antithesis to the non-ego. The rapid and solid growth and progress in knowledge which the child makes in its first ten years, under the care of parents and teachers, and the slower progress of the second decade, until it reaches complete maturity of mind, are intimately connected with a great advancement in the growth and development of consciousness and of its organ, the brain. But even when the pupil has got his 'certificate of maturity,' his consciousness is still far from mature: i is then that his world-consciousness first begins to develop, in his manifold relations with the outer world. Then, in the third decade, we have the full maturity of rational thought and consciousness, which in cases of normal development yield their ripe fruits during the next three decades. The slow, gradual degeneration of the higher mental powers, which characterizes senility, usually sets in at the commencement of the seventh decade, sometimes earlier, sometimes later: memory, receptiveness, and interest in particular objects gradually decay; though productivity, mature consciousness, and philosophic interest in general truths often remain for many years longer.

"The individual development of consciousness in earlier youth proves the universal validity of the biogenetic law; and, indeed, it is still recognizable in many ways during the later years. In any case, the ontogenesis of consciousness makes it perfectly clear that it is not an 'immaterial entity,' but a physiological function of the brain, and that it is, consequently, no exception to the general law of substance."

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and should be quoted here: "Another insoluble difficulty faces the athanatist when he asks *in what stage of their individual development* the disembodied souls will spend their eternal life. Will the newborn infant develop its psychic powers in heaven under the same hard conditions of the 'struggle for life' which educate men here on earth? Will the talented youth who has fallen in the wholesale murder of war unfold his rich, unused mental powers in Walhalla? Will the feeble, childish old man, who has filled the world with the fame of his deeds in the ripeness of his age, live forever in mental decay? Or will he return to an earlier stage of development? If the immortal souls in Olympus are to live in a condition of rejuvenescence and perfectness, then both the stimulus to the formation of personality and the interest therein disappear for them."[1]

III. The Pathological Argument

Lucretius: "Moreover we see that even as the body is liable to violent diseases and severe pain, so is the mind to sharp cares and grief and fear; it naturally follows, therefore, that it is its partner in death as well. Again, in diseases of the body the mind often wanders and goes astray; for it loses its reason and drivels in its speech and often in a profound lethargy is carried into deep and never-ending sleep with drooping eyes and head; out of which it neither hears the voices nor can recognize the faces of those who stand around calling it back to life and bedewing with tears face and cheeks. Therefore you must admit that the mind too dissolves, since the infection of disease reaches to it; for pain and disease are both forgers of death: a truth we have fully learned ere now by the death of many. Again, when the pungent strength of wine has entered into a man and its spirit has been infused into and transmitted through his veins, why is it that a heaviness of the limbs follows along with this? His legs are hampered as he reels about, his tongue falters, his mind is besotted, his eyes swim, shouting, hiccuping, wranglings are rife, together with all the other usual concomitants, why is all this if not because the overpowering violence of the wine is wont to disorder the soul within the body? But whenever things can be disordered and hampered, they

[1] *WR*., 208–9.

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give token that if a somewhat more potent cause gained an entrance, they would perish and be robbed of all further existence. Moreover it often happens that some one constrained by the violence of disease suddenly drops down before our eyes, as by a stroke of lightning, and foams at the mouth, moans and shivers through his frame, loses his reason, stiffens his muscles, is racked, gasps for breath fitfully, and wearies his limbs with tossing. Sure enough, because the violence of the disease spreads itself through his frame and disorders him, he foams as he tries to eject his soul, just as in the salt sea the waters boil with the mastering might of the winds. A moan too is forced out, because the limbs are seized with pain, and mainly because seeds of voice are driven forth and carried in a close mass out by the mouth, the road which they are accustomed to take and where they have a well-paved way. Loss of reason follows, because the powers of the mind and soul are disordered and, as I have shown, are riven and forced asunder, torn to pieces by the same baneful malady. Then after the cause of the disease has spent its course back and the acrid humors of the distempered body return to their hiding places, then, he first gets up like one reeling, and by little and little comes back into full possession of his senses and regains his soul. Since, therefore, even within the body mind and soul are harassed by such violent distempers and so miserably racked by sufferings, why believe that they without the body in the open air can continue existence battling with fierce winds? And since we perceive that the mind is healed like the sick body, and we see that it can be altered by medicine, this too gives warning that the mind has a mortal existence. For it is natural that whoever essays and attempts to change the mind or seeks to alter any other nature you like, should add new parts or change the arrangement of the present, or withdraw in short some tittle from the sum. But that which is immortal wills not to have its parts transposed nor any addition to be made nor one tittle to ebb away; for whenever a thing changes and quits its proper limits, this change is at once the death of that which was before. Therefore, the mind whether it is sick or whether it is altered by medicine, alike, as I have shown, gives forth mortal symptoms."[1]

[1] *De R. N.*, II, 469–522.

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Haeckel: "Pathological experiment yields the same result, the decay of some known area (for instance, the center of speech) extinguishes its function (speech). In fact, there is proof enough in the most familiar phenomena of consciousness of their complete dependence on chemical changes in the substance of the brain. Many beverages (such as coffee and tea) stimulate our powers of thought; others (such as wine and beer) intensify feeling; musk and camphor reanimate the fainting consciousness; ether and chloroform deaden it, and so forth. How would that be possible if consciousness were an immaterial entity, independent of these anatomical organs? And what becomes of the consciousness of the 'immortal soul' when it no longer has the use of these organs?"[1]

Naturally we do not expect to find in Lucretius any *histological* argument, "based on the extremely complicated microscopic structure of the brain," nor a *phylogenetic* argument, "deriving its strength from paleontology, and the comparative anatomy and physiology of the brain," nor any strictly *experimental* argument as to areas of function; but it is safe to say that not a single reader who fails to be convinced by Haeckel's other arguments would be moved by the three enumerated in this sentence, e. g., by the "quantitative and qualitative development of the brain of the placental mammals during the tertiary period."[2]

It would seem to me also safe to say that not a single reader who would fail to be converted by the *De Rerum Natura* would be seriously moved by the *Welträthsel*. Of course, the latter marshals all the argumentative panoply of our wonderful modern science, with its countless facts and illuminating theories, and the mere enumeration of the arguments given above suggests the arms that a modern monist may take into his hands; but the new arms, it seems to me, would reach

[1] *WR.*, 184. Of course, the localization of the organs of thought in the modern sense is entirely unknown to Lucretius, so that his arguments are naturally drawn from "the most familiar phenomena of consciousness." He actually thought of the breast as the central seat of consciousness with the vital principle extending through every part of the body. "Now I assert that the mind and soul are kept together in close union and make up a single nature, but that the directing principle which we call mind and understanding, is the head, so to speak, and reigns paramount in the whole body. It has a fixed seat in the middle region of the breast; here throb fear and apprehension, about these spots dwell soothing joys; therefore here is the understanding or mind. All the rest of the soul disseminated through the whole body obeys and moves at the will and inclination of the mind."—*De R. N.*, III, 136–44.

[2] *WR.*, 204–205.

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only the breasts that would have been reached by the old. In this fact, for so I consider it, the reader who feels that a monistic attitude towards immortality is hostile to the best progress of humanity must find no little comfort. Such a person, after carefully examining the arguments in these two representative thinkers, must inevitably cry out in joy that monism's vaunted science leaves its latest and greatest exponent quite as unconvincing as the comparatively unschooled Roman of two thousand years ago. "Here," he would say, "is after all the same old crying in the night, with no more convincing power in the cry." On the other hand, he who compares the two men with a feeling that their monistic attitude towards immortality is essentially right will insist that, while Lucretius and Haeckel so fundamentally agree, the latter brings to bear a tremendous advance in detailed scientific proof. He will point out that Haeckel represents the clear light of mid-morning, whereas Lucretius speaks from a dim and early dawn; but he must feel that they greet the same sun and belong to the same day.

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TRICORYTHUS, A GENUS OF MAYFLIES.

By T. D. A. Cockerell and Marie Gill

The genus *Tricorythus* was proposed by Eaton in 1868, to contain a mayfly from Egypt, described by Pictet in 1843–1845 as a *Cænis*. Subsequently a species described by Burmeister in 1839 as *Oxycypha discolor*, from the Cape of Good Hope, was added. Burmeister's genus *Oxycypha* consisted of two species of *Cænis* and one of *Tricorythus;* as *Cænis* Stephens dates from 1835, by the "elimination method," followed by many zoölogists, we should be obliged to use the name *Oxycypha* for *Tricorythus*. The first species of *Oxycypha*, however, was *Cænis dimidiata*. A third *Tricorythus* was reported by Eaton in 1884 as coming from the Malay Archipelago, but the species was not named, the material being inadequate for a satisfactory description.

So far, no species of the genus had occurred in America; but in the *Biologia Centrali-Americana* (1892) Eaton described a new species, *T. explicatus*, collected by Morrison in "Northern Sonora," which, it is understood, may mean northwestern Mexico or southern Arizona. The same species was recorded from Jalapa, Mexico, by Banks in 1901, and from Copper Basin, Ariz., also by Banks, in 1903. On October 7, 1905, many mayflies were found emerging from a stream a few miles from Boulder, Colo. At the same time and place nymphs were collected, but no flies were bred from observed nymphs. When we came to examine the insects, we believed that we had a new species of *Cænis;* but Dr. Needham, to whom we sent specimens, kindly pointed out that they were apparently Eaton's *Tricorythus explicatus*, and later enabled us to examine Eaton's description and figures, which had not been accessible. Upon comparing our material with the published account of *T. explicatus*, it was evident that the species was the same, and that the range must be extended some hundreds of miles northward. It is probable that Boulder represents nearly

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one extreme of climate possible for the insect, as with us maturity seems only to be reached quite at the end of the season.

The genus *Tricorythus*, nevertheless, has a much more northern range; for Dr. Needham also pointed out that his *Cænis* (?) *allecta*, from Ithaca, N. Y., should be known as *Tricorythus allectus*.

The nymph of *Tricorythus* is not certainly known. The *Cænis maxima* Joly, from France (near Toulouse) was referred by Vayssière to *Tricorythus*, and is provisionally accepted as such by Eaton, though with considerable hesitation. It is known only from the nymph, which is figured in detail by Eaton, and it is significant that no adult *Tricorythus* has ever been seen in France or nearer thereto than Egypt. This nymph has all the essential characters of a *Cænis*, differing only in slight details from the known members of that genus. Dr. Needham (*Bull. 86, N. Y. State Museum*, p. 48) has described the nymph of *T. allectus*, not, however, going into very minute details. He has very kindly sent us some of these nymphs, stating, however, that they were not bred, and that he is now doubtful whether they should not be referred to *Cænis hilaris*, which was found at the same place. We find these nymphs to agree, so far as can be seen, with *Cænis*, and it is perhaps safe to dismiss them as not pertaining to *Tricorythus*.

There now remains the nymph collected near Boulder, at the locality of *T. explicatus*. It certainly has no intimate relationship with *Cænis maxima*, or with Dr. Needham's specimens. These have the large maxillary palpi of *Cænis*, while ours has the same palpi greatly reduced, and altogether as in the *Ephemerella* series. The mandibles of our nymph greatly resemble those of *Cænis maxima*, but they are not unlike those of other allied genera. The maxillæ are about as in the "nameless ally of *Ephemerella*," figured by Eaton in his monograph, Plate 38, Figs. 4, 5. The labrum presents nothing especially remarkable; the claws have about ten little denticles on the inner side; the gill lamellæ are not fringed; and while there is a large elytroid lamella, as in *Cænis maximus* and in true *Cænis*, it is not subquadrate, but triangular. There are no rows of dorsal hooks on the abdomen, so that in Needham's table of nymphs of the *Ephemerella* type ours falls

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with the nameless one from Colorado, figured by Eaton on his Plate 39. It agrees with that also in the robust form, but differs in the structure of the head, etc.

If the Boulder nymph really belongs to *Tricorythus*, as seems hardly doubtful, it apparently follows that that genus has been derived from the *Ephemerella* series by the loss of the hind wings and reduction of the venation, and has really no intimate relationship with *Cænis*.

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ON A NEW α, δ DIHYDROQUINOXALINE

By John B. Ekeley

The author, in conjunction with R. J. Wells,[1] has shown that, when orthophenylenediamine reacts with acetone or with mesityloxide in the presence of dry hydrochloric acid gas, a condensation takes place with the formation of a new dihydroquinoxaline. The substance was interesting in that it was the first member to be isolated of a theoretically possible series of dihydroquinoxalines having two imido groups. It therefore ought to be possible to produce other members of the series by using other diamines. Numerous trials with orthotoluylenediamine (1:3:4) and with para-ethoxy-orthophenylenediamine have been barren of results, and from these no base up to the present has been isolated. In the case of orthoxylylenediamine (1:3:4:5), however, the reaction takes place with almost the same ease as in the case of orthophenylenediamine, and the base formed shows similar properties. It is a di-acid base, yields characteristic salts, and without doubt is another member of the series.

Ten grams of orthoxylylenediamine[2] were dissolved in an excess of mesityloxide, cooled, and a stream of dry hydrochloric acid gas passed through the solution. In a short time the hydrochloric acid salt of the base was precipitated. This was pressed out on a porous plate, dissolved in water, filtered, and treated with a strong solution of potassium hydroxide. The straw-colored precipitate of the new base was filtered off, pressed out on a porous plate, and recrystallized from dilute acetone. It yields straw-colored needles, extremely soluble in most organic solvents and in acids. Melting point, 82°–83°.

CARBON AND HYDROGEN DETERMINATION

.2931 grm. substance yielded .8356 grm. CO_2 and .2475 grm. H_2O.

$C_{14}H_{20}N_2$, C = 77.75% Found, 77.77% Calc.
" H = 9.41 " 9.26 "

[1] This journal, Vol. II, No. 2, p. 123, and *Berichte der Deutchen Chem. Ges.*, 38, 2259.

[2] The diamine may be obtained with a splendid yield by the reduction of orthonitrometaxylidine with zinc dust and sodium hydroxide by the method of Hinsberg.

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NITROGEN DETERMINATION

.2544 grm. substance yielded 35.1 c.c. Nitrogen at 615.6 m.m. and 18°.

$C_{14}H_{20}N_2$, N = 13.16% Found, 12.98% Calc.

SALTS OF THE BASE

Hydrochloric acid salts.—A stream of dry hydrochloric acid gas was led into a solution of the base in ether. At first a lemon yellow precipitate was formed, which quickly changed to white. The white precipitate, which was made up of minute crystals, proved on analysis to be a di-hydrochloric acid salt.

HYDROCHLORIC ACID DETERMINATION

.2654 grm. substance, dissolved in water, required for neutralization 13.7 c.c. of a .13572N.NaOH solution.

$C_{14}H_{20}N_2$, 2HCl, HCl = 25.54% Found, 25.26% Calc.

The yellow salt first precipitated could not be separated pure on account of the speed with which it changed to the white salt. It is, however, without doubt a mono-hydrochloride, as several analyses of the impure substance showed.

Hydrobromic acid salts.—From an ether solution of the base, dry hydrochloric acid gas precipitates first a yellow mono-hydrobromide which also quickly takes on more hydrobromic acid and becomes a white crystalline di-hydrobromide.

HYDROBROMIC ACID DETERMINATION

.1944 grm. substance, dissolved in water required 7.55 c.c. of a .13572 N.NaOH solution.

$C_{14}H_{20}N_2$, 2HBr, HBr = 42.68% Found, 42.85% Calc.

Action of hydriodic acid gas.—Hydriodic acid gas precipitates from an ether solution of the base, first a yellow and then a white salt, but, at the same time, some decomposition takes place so that the salts can not be obtained pure for analysis.

Action of hydrochloric acid gas upon a chloroform solution of the base.—A rather peculiar phenomenon appears when dry hydrochloric acid gas is passed through a chloroform solution of the base. Instead of a crystalline precipitate of the salt being thrown down, apparently a

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colloidal solution of the salt in chloroform is formed, which has very much the appearance of a thick starch solution. A comparatively dilute chloroform solution of the base becomes semi-solid. If water is added to a portion of this in a test tube, the colloidal solution assumes the form of a sphere, within the outer chloroform shell of which floats a nucleus of undissolved salt. This will last a long time, even though the water be hot. If the colloidal solution be allowed to evaporate upon a watch-glass, a tough parchment-like residue remains behind, which retains the odor of chloroform for days. This residue dissolves in water to the ordinary aqueous solution of the salt.

Comparison of the above salts of this base with those of the base from orthophenylenediamine.—The halogen acid salts of this base are, like those of the base from orthophenylenediamine, yellow and white. Their aqueous solutions are, like those of the other base, yellow when dilute and colorless when concentrated. They can serve as their own indicators on titration with alkalis, the change of color of the solution from yellow, due to the complex kation, $C_{14}H_{22}N_2$, to colorless being very sharp. Hydrochlorplatinic acid gives with the salts of this base no precipitate, the chlorplatinate being extremely soluble in water.

Picric acid salt.—When an ether solution of the base is mixed with an alcoholic solution of picric acid, beautiful lemon yellow crystals of a picrate of the base separate out.

NITROGEN DETERMINATION

.2102 grm. substance yielded 36.5 c.c. Nitrogen at 613.2 m.m. and 20°.

$C_{14}H_{20}N_2 \cdot 2C_6H_2(OH)(NO_2)_3$ N = 16.39% Found, 16.61% Calc.

ACTION OF NITROUS ACID

If a potassium nitrite solution is added to a dilute acetic acid solution of the base, a nitroso product is formed. It becomes gummy, and looks very much like the corresponding product from the base from orthophenylenediamine. In this case, however, the impurities could not be removed, so that no crystals were obtained. The impure substance shows the Liebermann's blue coloration, and is without doubt an impure nitroso compound.

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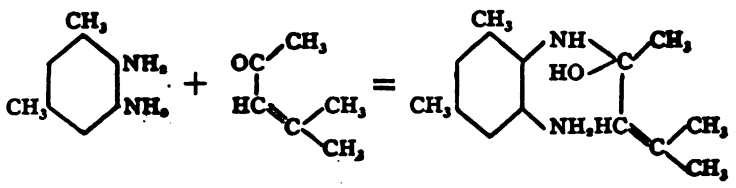
No benzoyl derivative could, as with the former base, be obtained, nor was an acetyl derivative formed. The base, however, forms precipitates similar to those from the other base with certain metallic salts. With copper sulphate solution at first a green coloration is produced by an alcohol solution of the base; a green precipitate then forms, which becomes black upon warming, probably with the formation of copper oxide. From a mercuric chloride solution a bright yellow precipitate is produced. Ferric hydroxide is also precipitated from ferric solutions.

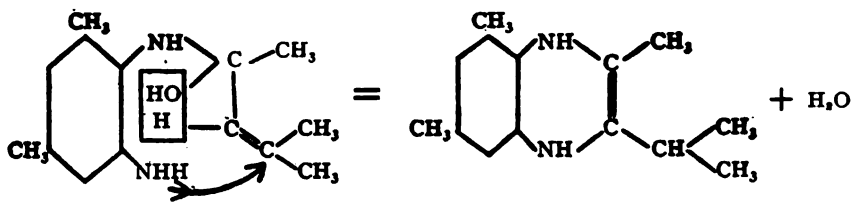
From the above facts there seems to be no doubt that we have here a second member of a series of α, δ dihydroquinoxalines. Comparing the two members of the series, at present known, with the α, β dihydroquinoxalines, we find that, whereas the latter give green-yellow fluorescent solutions, these give golden yellow; the α, δ series is more basic in character, its salt solutions are yellow when dilute and colorless when concentrated, while those of the α, β series are bright red.

The reaction between orthoxylylendiamine and mesityloxide may be represented by the following equations:

First an addition of the amine to the carbonyl group of the ketone takes place,



Water is then split off with the formation of the quinoxaline ring.



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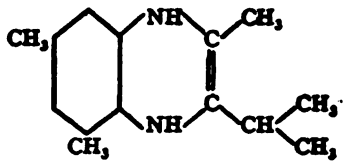
Of course the constitution could just as well be



It is the intention to study the action of other orthodiamines, both aliphatic and aromatic, upon mesityloxide and upon other unsaturated ketones, with the hope of isolating other members of this series.

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THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO

By Junius Henderson

During the summer of 1905 an expedition, under the auspices of the University of Colorado, visited the ancient lake basin at Florissant, Colo., about 40 miles west of Colorado Springs and 20 miles from Cripple Creek. Large and valuable collections of both fossil and recent plants and animals were secured. As a result, some hitherto unnoticed species have already been described from that region, and it is hoped that further information of importance may be given to the scientific world as work progresses.

The literature of the Florissant formation is scattered through numerous monographs, reports, and other publications which are not much read except by those engaged in special geological or biological studies. Consequently this interesting region is not well known to the general public. It is therefore deemed best to publish this account setting forth in a general way some of the principal facts observed by us or hitherto published by others, with a few comments thereon, together with hints as to unsettled questions and a bibliography of the literature of the subject, so far as known to the writer.

The Tertiary lake beds of Florissant have long been known to geologists, and particularly to paleontologists, because of the great number and variety of fossil plants and insects they contain, besides some fossil fish, mollusks, and birds. The basin is one of the most important in the world for fossil insects, and fossil leaf impressions may be easily collected by thousands.

These beds have generally been assigned to the Oligocene division of the Tertiary age, but it is perhaps more in accordance with modern American usage to consider the Oligocene merely the upper part of the Eocene, and hence to call the Florissant formation Eocene. The determination of the age of this formation necessarily depends entirely upon paleontological methods. As the deposits were formed in a

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mountain valley, and are underlaid by granite and completely isolated from all other sedimentaries by several miles of crystalline rocks, stratigraphy can throw no light whatever upon the subject. Any deformation which may have occurred in the valley would be difficult to locate or to follow at all through the granitic complex, even if it extended to rocks of known age, so that no help could reasonably be expected from that source. The presence of masses of rhyolite along and near the margins of the ancient lake is of no assistance, because of the impossibility of determining their age exactly in the crystalline mass, and the character of the materials composing the lake beds themselves is wholly valueless as evidence of age, as similar materials might have been available at periods long prior and subsequent to the lake period.

The fossils have been considered indicative of a much milder climate than that which now prevails in the region. It has been stated that the fossil flora and fauna of the vicinity are in a general way similar to the present-day flora and fauna of the Gulf states, though specifically, and to a considerable extent generically, distinct. Scudder has shown that, while the fossil insect fauna exhibits distinct tropical affinities, there is also a very definite relation to the present insect fauna of the region. The latter relation applies also to the fossil and recent flora. The fluctuation in climate since Eocene time has been much greater than indicated by the difference in plant and animal life as shown by the fossils of Florissant. The glacial epoch has intervened, during which time, although glaciers apparently did not actually reach this valley, they were in such close proximity and so extensive through the higher mountains that the climate was probably considerably colder than now, and differed in other respects, such as precipitation, relative humidity, etc., from that of either Tertiary time or the present day.

Many giant fossil *Sequoia* stumps and logs are found in the southern part of the lake basin. These have been visited by hundreds of tourists, and large quantities of the "petrified wood" have been carried away by relic-hunters. Several years ago an effort was made to cut the largest stump into three or four sections for transportation and exhibition, but the attempt met with failure, and portions of the broken

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saws still remain in the stump. A photograph of one of these stumps is reproduced in Fig. 3.

It was long ago pointed out that the drainage and destruction of the lake were probably brought about by the tilting of the region from the southeast, reversing the drainage and causing the lake to overflow its northwestern rim and cut down its barrier at that end. It is believed that the valley formerly drained southward into the Arkansas River, but now, with the exception of the extreme southern portion, the drainage is westward into the South Platte. The southeastern end of the basin, instead of being lower than the northwestern extremity, is now about 800 feet higher.[1] If the lake was in fact thus drained, it is interesting to note that at present the basin formerly occupied by it still drains partly to the south, as a glance at the accompanying map will show. This means either: (1) that the drainage was not wholly reversed, but that the axis of the deformation crossed the lake near the southern end, thus dividing it into two portions, one draining into the Arkansas and the other into the South Platte; or (2) that the drainage of the southern portion has been captured in more recent times by the headward progression of the channel from the south.

In the literature of the subject there appears to be no hint as to the origin of the lake, and in the field we have found nothing to suggest any of the known causes of mountain lakes except the warping of the earth's crust. As there is evidence of a general tilting of the region either during or subsequent to the deposition of these beds, it seems quite possible that it was only a continuation of the process which originally created the lake. The great majority of mountain lakes of Colorado are glacial, in this respect differing from the lakes of the plains. Lake Florissant was certainly not glacial. The geological map shows a volcanic accumulation south of the basin in such position as to act as a possible barrier. This we did not visit. It should be examined with reference to this problem before any final conclusion is reached. Barriers of gravel and boulders produced by the outwash from high-grade lateral gulches and in other ways would not seem sufficient to account for this lake and its deposits.

[1] Twelfth Ann. Rept., *Hayden Survey*, Part 1, p. 274.

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The whole topography of the region indicates that the basin was formerly a mountain valley and its laterals, formed in granite by stream erosion, and hence thoroughly drained, in this respect resembling the original valleys of glacial lake basins. This is obvious to the physiographer from an examination of the accompanying map. The ramification of the lake into lateral valleys and consequent tortuous outline gives a great length of shore line in proportion to the area. It consisted of two somewhat distinct bodies of water connected by a narrow strait and placed at such an angle with each other as to form a rude L; or, to state it another way, the lake was nearly divided at the angle by two promontories which jutted into it from opposite shores.

It seems certain that a lake could originate and continue its existence in such a valley for a sufficient length of time to permit the deposition of these beds only by the formation of a very resistant barrier in such a position as to interrupt the drainage. Such a barrier of rock could have been formed in several ways: (1) by volcanic accumulations choking the valley, (2) by a sharp fold thrown across the channel, (3) by the general tilting of the region resulting either from an uprising to the southeast or a depression to the northwest, or both. From the evidence so far at hand, it seems more likely that the last is what occurred. As soon as such a change in level had progressed far enough to raise a downstream portion of the valley to a position higher than any portion further upstream, the water would begin to accumulate, the vertical longitudinal section of such a valley being concave. The accumulation would continue until either the tilting ceased or the lake overflowed its rim at some point other than its original outlet; but that does not necessarily mean that the lake would attain great depth. The character of some of the fossils, the *Sequoia* stumps standing erect in the deposits, and reported sun-cracks in the shales indicate that the filling of the lake by detritus progressed approximately as rapidly as the supposed tilting, so that the lake was maintained in a rather shallow condition.

In the accompanying diagram (Fig. 2) an effort is made to illustrate graphically this supposed change of level and its effect, the vertical

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scale being grossly exaggerated in proportion to the horizontal scale, in order to appeal more readily to the eye.

That the time of the existence of this lake was one of great volcanic activity in the region is quite evident. This conclusion does not depend merely upon the stratigraphic relations of volcanic rocks to the lake beds, but more particularly upon the character of the sedimentary deposits themselves. These beds are composed chiefly of volcanic ashes, mud and sand, the component particles of which are generally somewhat, though not very much, worn by the action of the water. The conclusion reached in both field and laboratory is that the deposits were formed largely by volcanic ashes from repeated eruptions falling upon the surface of the water and settling to the bottom, assorted by the sluggish lake currents; also by volcanic mud and ashes falling or flowing into positions where they were rapidly washed into the lake by rains, streams, and waves without very much grinding.

The strata of the upper deposits differ greatly from each other in composition, fineness of material, and thickness. At least the whole fossiliferous portion examined has been deposited in water, is thin-bedded, and very distinctly stratified. It often weathers out in large scales little thicker than ordinary writing-paper. During the periods of deposition large numbers of insects and plants were sometimes entombed and preserved in great perfection. While there is a general sameness to the formation in various parts of the basin, yet, upon more particular examination of the strata, great dissimilarity in minor details forces itself upon the attention. Especially is this true when one compares a vertical section in the northwestern basin with one in the southeastern basin.

The lower part of the formation seems wholly non-fossiliferous, is of a drab color, quite homogeneous, thick-bedded, and has a decidedly conchoidal fracture. Our limited examination of that portion of the formation left the impression that it was formed by mud flows without much assortment by moving water. This is offered merely as a suggestion for future work, not as a final conclusion, and its investigation may throw important light on the history of the lake. Near the northwestern end of the basin a shaft has been sunk for some

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distance into the non-fossiliferous beds, and in other places wells have been sunk, affording excellent sections and showing that the floor deposits extend to considerable depth—just what depth we have not learned. The fossiliferous beds above the floor deposits are approximately twenty feet in thickness.

The dip of strata is in most places to the northwest, as would be expected in view of the supposed tilting, and is not usually very marked. The beds are not entirely free, however, from local disturbance. In one place we found a very decided change in both direction and angle of dip within a few yards, but the intervening rocks were deeply buried by débris, so we were unable to ascertain whether it was a fault or fold. Near the southern end of the basin the shales seem to be involved with igneous rocks, but limited time prevented a thorough examination as to the nature of the disturbance.

Volcanic rocks bordered and projected into the lake in many places. To a layman perhaps the most interesting feature of the igneous rocks is an exposure a few rods north of Florissant post-office. The deposit is much shattered, the cracks varying from a fraction of an inch to several feet in width. It is reported that these crevices afforded hiding-places for the Indians in their wars with neighboring tribes before the advent of white men, and rude fortifications remained there long after the settlement of the valley.

Since the deposition of the beds and the drainage of the lake, the valley has been subjected to extensive erosion. The fossiliferous part of the lake formation, consisting chiefly of soft, yielding shales, has mostly been cut away, leaving remnants, however, along nearly the whole margin, not only of the main shore, but also of the granitic hills which once formed islands in the lake. There is no reason to doubt that at many of the outcrops the top of the formation still remains intact, so that a complete section of the entire formation is obtainable. The exposed shales are usually so badly weathered that the contained fossils cannot be obtained in good condition, but upon steep slopes it is easy to excavate sufficiently with pick and shovel to reach unweathered deposits in which may be found fine specimens. The floor deposits are mostly covered by alluvium and talus, and are thus hidden from view.

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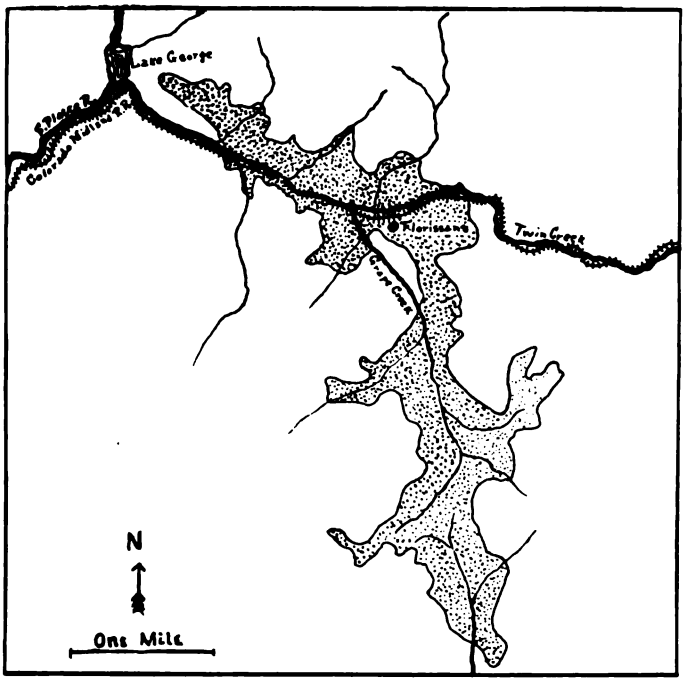

FIG. 1

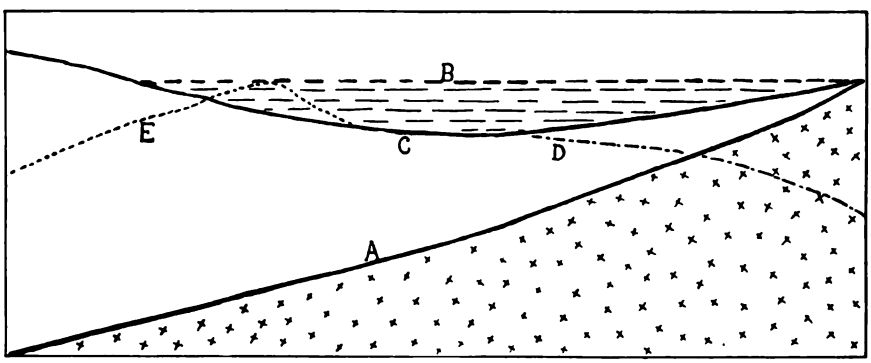

FIG. 2

FIG. 3
THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO
See "Explanation of Figures"

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Many of our smaller mountain "parks" or meadows in Colorado are the result of the silting up and drainage of glacial lakes, though if stratified deposits were formed in the lakes, they have usually been almost wholly worked over and destroyed by the subsequent meandering of the streams. Such parks in many respects resemble the Florissant valley. Compared with Estes Park, South Boulder Park, Nederland meadows, and other more northerly valleys which are becoming well known to the traveling public, the Florissant basin is more open, not as well defined, and presents an aspect of greater age. The surrounding mountains are neither as high nor as abrupt, being for the most part rounded into gentle slopes, without deep, sharp, V-shaped gorges. The highest point within a radius of several miles is only 1,000 feet above the village of Florissant, which is situated on the present floor of the valley, a little over 8,000 feet above sea-level.

Two other Tertiary lake basins are noted on the maps of the Pike's Peak folio, but they are of later origin, being considered Neocene. One is called Alnwick Lake, the other High Park Lake. They are a few miles south of Florissant, one immediately northwest and the other southwest of Cripple Creek. Their deposits are very different from those of Florissant, consisting of sandstones and conglomerates, and seem to be devoid of fossils.

EXPLANATION OF FIGURES

FIG. 1.—Outline map of Florissant Tertiary lake basin, following Folio No. 7, *Geological Atlas of the United States*. The present extent of lake beds is indicated by dotted area. Drainage at present is shown by the courses of the streams.

FIG. 2.—*A*, original slope of valley floor. *B*, water level at beginning of overflow at northwest end. *C*, valley floor after supposed tilting. *D*, valley floor after cutting down of barrier and draining of lake. *E*, dotted line represents the possibility of the axis of deformation having divided the lake near the southern extremity. Vertical scale is greatly exaggerated. Left of figure is southeast; right of figure is northwest.

FIG. 3.—Fossil *Sequoia* stump. The framework was erected at the time that an attempt was made to cut sections of the stump for exhibition.

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* * * * * * "On some new species of fossil plants from the Lignite formations," *Bull. Hayden Survey*, Vol. I, 2d Ser., No. 5, 1876, pp. 363–389.

* * * * * * "Contributions to the fossil flora of the western territories. Part II, The Tertiary flora." *Mon. Hayden Survey*, Vol. VII, 1878.

* * * * * * "Contributions to the fossil flora of the western territories. Part III, The Cretaceous and Tertiary flora." *Mon. Hayden Survey*, Vol. VIII, 1883. On page 132, in transposing centimeters of the original tabulated cross-section into feet and inches, the measurements were apparently stated in inches and fractions thereof, but unfortunately the column was headed in such a way as to indicate that the inches are feet and the fractions are inches, thus greatly multiplying the thickness of strata.

NEWBERRY, J. S. "Brief descriptions of fossil plants, chiefly Tertiary, from western North America." *Proc. U. S. Nat. Mus.*, Vol. V, 1882, pp. 502–514.

SCUDDER, S. H. "Critical and historical notes on Forficulariæ." *Proc. Boston Soc. Nat. Hist.*, Vol. XVIII, 1876, pp. 287–332. Includes two fossil forms from Florissant.

* * * * * * "Fossil Orthoptera from the Rocky mountain Tertiaries." *Bull. Hayden Survey*, Vol. I, 2d Ser., No. 6, 1876, pp. 447–449.

* * * * * * "Fossil Coleoptera from the Rocky mountain Tertiaries,"

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Bull. Hayden Survey, Vol. II, No. 1, 1876, pp. 77–87. Includes several species from Florissant.

* * * * * * "Brief synopsis of North American earwigs, with an appendix on the fossil species," *Bull. Hayden Survey*, Vol. II, No. 3, 1876, pp. 249–260. Discusses one species and describes another from Florissant.

* * * * * * "Note on fossil ants from South Park, Colorado." *Amer. Nat.* Vol. XI, 1877, p. 191. Mentions that about 40 species have been found at Florissant, but does not describe them.

* * * * * * "An account of some insects of unusual interest from the Tertiary rocks of Colorado and Wyoming." *Bull. Hayden Survey*, Vol. IV, No. 2, 1878, pp. 519–543. Species discussed are mostly from Florissant. Strongly urges tropical affinities.

* * * * * * "The Tertiary lake basin at Florissant, Colorado, between South and Hayden Parks." *Twelfth Ann. Rept. Hayden Survey*, Part 1, 1878, pp. 271–293. Reprint from *Bull. Hayden Survey*, Vol. VI, although it antedates the completed Vol. VI. Topographical and geological description, with map and discussion of fossils.

* * * * * * "The insect basin of Florissant." *Psyche*, Vol. III, 1880, p. 77.

* * * * * * "The Tertiary lake basin at Florissant, Colorado, between South and Hayden Parks." *Bull. Hayden Survey.*, Vol. VI, No. 2, 1881, pp. 279–300. A general account of the basin, its geology and fossils, with map. Reprinted in *Twelfth Ann. Rept.*, and *Thirteenth Mon.*, of same survey.

* * * * * * "White ants in the American Tertiaries." *Harv. Univ. Bull.*, Vol. II, 1881, p. 219. Discusses relations of six Florissant species to those from other localities and notes indications of warm climate.

* * * * * * "Insects of the Amyzon shales of Colorado." *Amer. Nat.*, Vol. XVI, 1882, pp. 159–160. Discusses climatic conditions.

* * * * * * "Fossil spiders." *Harv. Univ. Bull.*, Vol. II, 1882, pp. 302–303. Reprint: "Our knowledge of fossil spiders." *Field Nat.*, Vol. I, 1882, pp. 61–63, Manchester, Eng.

* * * * * * "Notes on some of the Tertiary Neuroptera of Florissant, Colorado, and Green River, Wyoming." *Proc. Boston Soc. Nat. Hist.*, Vol. XXI, 1882, pp. 407–409.

* * * * * * "Description of an articulate of doubtful relationship from the Tertiary beds of Florissant, Colorado." *Mem. Nat. Acad. Sci.*, Vol. III, 1885, pp. 85–90.

* * * * * * "Systematic review of our present knowledge of fossil insects, including myriapods and arachnids." *Bull. U. S. Geol. Sur.*, No. 31, 1886.

* * * * * * "Fossil butterflies of Florissant." *Eighth Ann. Rept. U. S. Geol. Sur.*, 1889 pp. 433–474. Reviewed in *Nature*, Vol. XIII, 1890, p. 18, and *Amer. Geol.*, Vol. VI, 1890, p. 197.

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* * * * * * "A classed and annotated bibliography of fossil insects." *Bull. U. S. Geol. Sur.*, No. 69, 1890.

* * * * * * "Physiognomy of the American Tertiary Hemiptera." *Proc. Boston Soc. Nat. Hist.*, Vol. XXIV, 1890, pp. 562–579. Shows definite relation of western Tertiary fauna to that at present occupying the region, with, however, distinct tropical affinities.

* * * * * * "The Tertiary insects of North America." *Mon. Hayden Survey*, Vol. XIII, 1890, pp. XI, 127–217. Includes the descriptive matter and map from *Bull.* Vol. VI, in addition to descriptions and plates of fossil insects.

* * * * * * "Work of a decade upon fossil insects, 1880–1889." *Psyche*, Vol. V, 1890, pp. 287–295.

* * * * * * "The Fossil insect localities in the Rocky Mountain Region." *Psyche*, Vol. V. 1890, p. 362. Discusses relative abundance of individuals of different orders.

* * * * * * "Index to the known fossil insects of the world, including myriapods and arachnids." *Bull. U. S. Geol. Sur.*, No. 71, 1891.

* * * * * * "Brief notes of a new fossil butterfly." *Psyche*, Vol. VI, 1891, p. 101. (*Barbarothea florissanti*).

* * * * * * "Fossil insects." *Psyche*, Vol. VI, 1891, p. 118. Discusses fossil plant-lice from Florissant and remarks on *Barbarothea*.

* * * * * * "Some insects of special interest from Florissant, Colorado, and other points in the Tertiaries of Colorado and Utah." *Bull. U. S. Geol. Sur.*, No. 93, 1892.

* * * * * * "Tertiary Rhynchophora of North America." *Proc. Boston Soc. Nat. Hist.*, Vol. XXV, 1892, pp. 370–386. Apparently a preliminary sketch of his monograph on the same subject published shortly afterwards by the U. S. Geol. Sur.

* * * * * * "American Tertiary Aphidae." *Thirteenth Ann. Rept. U. S. Geol. Sur.* 1892, pp. 341–366.

* * * * * * "The Tertiary rhynchophorous Coleoptera of the United States." *Mon. U. S. Geol. Sur.*, Vol. XXI, 1893.

* * * * * * "Tertiary Tipulidae, with special reference to those of Florissant, Colorado." *Proc. Amer. Philos. Soc.*, Vol. XXXII, 1894, pp. 163–245. Abstracts: *Amer. Nat.*, Vol. XXVIII, 1894, pp. 951–954; *Amer. Journ. Sci.*, Vol. XLVII, 1894, p. 481.

* * * * * * "American fossil cockroaches." *Bull. U. S. Geol. Sur.*, No. 124, 1895.

* * * * * * "Adephagus and clavicorn Coleoptera from the Tertiary deposits at Florissant, Colorado." *Mon. U. S. Geol. Sur.*, Vol. XL, 1900.

WARDER, R. B. "The silicified stumps of Colorado." *Proc. 31st Ann. Meet.*

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Amer. Assn. Adv. Sci., 1883, pp. 398–399. Discusses the *Sequoia* stumps and associated leaf impressions at Florissant, particularly the extremes o annual growth rings, and suggests the possibility of hot silicious waters from volcanic springs.

WILLISTON, S. W. "Some interesting new Diptera." *Trans. Conn. Acad. Arts and Sci.*, New Haven, Conn., Vol. IV, 1880, pp. 243-246. Discusses some Florissant species.

* * * * * * "Synopsis of North American Syrphidae." *Bull. U. S. Nat. Mus.*, No. 31, 1886. Contains a brief section on geological distribution, including Florissant species, but incorrectly cites the U. S. Geol. Sur. instead of Hayden Survey or U. S. Geol. and Geog. Sur. of the Terr., the two surveys and their publications being distinct and each having published bulletins, etc., bearing the same numbers.

VON ZITTEL, KARL A. *Text-book of paleontology*. American edition, 1900, Vol. I, pp. 682–691. Figures some Florissant species to illustrate genera.

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THE FOSSIL FAUNA AND FLORA OF THE FLORISSANT (COLORADO) SHALES

By T. D. A. Cockerell

The Tertiary lake basin of Florissant, Colo., is one of the most famous localities for fossils in the world. The plants and insects of a past age are wonderfully preserved in fine volcanic sand or ash, deposited in layers which readily split apart, revealing the specimens, just as they fell, in prodigious numbers. Green leaves and even branchlets were torn from the trees, and insects perished wholesale, in a catastrophe which must have equaled that of Martinique. There were, in fact, several successive eruptions, as about a dozen different horizons are found to be fossiliferous. While some of these may represent a single period of volcanic activity, it is not to be doubted that considerable periods elapsed between some of the deposits. Perhaps the non-fossiliferous shales were deposited so soon after the fossiliferous ones that no living creatures remained to be entombed, all having been destroyed or driven away; in this case the next fossil-bearing layer will indicate a new eruption, following after a greater or less lapse of time.

In all eleven vertebrates, one mollusc, 610 insects, 30 spiders, and about 145 recognizable plants have been described from these beds. The insects were all described by Mr. S. H. Scudder, except a few plant-lice named by Mr. Buckton from drawings supplied by Mr. Scudder, and some hymenoptera recently examined by the present writer. The Scudder collection, at the Museum of Comparative Zoölogy, Cambridge, Mass., contains probably at least another 400 species of insects. These were to have been described by Mr. Scudder, but he is no longer able to work upon them, and others will be obliged to do the best they can in the absence of the master hand. Mr. Samuel Henshaw, curator of the Museum of Comparative Zoölogy, has very kindly transmitted to me the bees and wasps for study, and the work on them is already completed.

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The plants were catalogued in 1898 (*Trans. St. Louis Acad.*) by Mr. W. C. G. Kirchner, who contrived to enumerate as many as 213 species. He included, however, all the indeterminate things, many obsolete identifications, and some duplicates; with a more careful examination, even with the addition of some new species discovered by Judge Henderson and Dr. Ramaley, I cannot find more than about 145 really recognizable species.

A paper on the new species of plants has been sent for publication elsewhere; in addition, several new names have been proposed to to replace homonyms, and these will be recorded in the same paper. Should circumstances permit, it is hoped to work up the Florissant beds in detail, with the idea of presenting as perfect a picture as possible of the life of the period they represent. There is, perhaps, no locality in the world where so many terrestrial species of one time are preserved; and if every advantage is taken of the splendid opportunity afforded, the result should be of great value to biological and geological science. The work should, of course, employ many hands; it is far too great for any single individual, though such an individual may have a general oversight of the entire field, and piece together the contributions of specialists. It is much regretted that the splendid publications of Scudder and Lesquereux have not attracted more critical attention, as the advice of specialists on many points is greatly needed. Fortunately, the ants are to be studied by Dr. W. M. Wheeler, and his researches are sure to be of extreme interest.

There is one aspect of the Florissant insect fauna which is of the greatest importance to the student of evolution; namely that explained by Mr. Scudder in the following words:

> In my recent work on our Tertiary insects, I called attention to some remarkable features in the fossil plant-lice of our Tertiaries, especially the great length and slenderness of the stigmatic cell—a feature which affects the whole topography of the wing, and is found also in the only Mesozoic plant-louse known, but which, nevertheless, cannot be regarded as of significant taxonomic importance since it occurs equally in both Aphidinæ and Schizoneurinæ, the two principal subfamilies of that group, both today and formerly. So, too, in treating in the same place the Pentatomidæ, I pointed out that the scutellum was universally shorter in all our Tertiary forms, whether belonging to the subfamily of Cydninæ or Pentatom-

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inæ. I may further add the unpublished fact that it is a peculiarity of the Tertiary Staphylinidæ of this country that the antennæ and legs are measurably shorter than in modern types; this is most marked in cases where the living and extinct species of the same genera are compared.—*Tertiary Rhynchophorous Coleoptera*, 1893, p. 2.

Thus we find, among the insects, indications of common trends of variation similar to those observed by H. F. Osborn and others among the vertebrates. Professor Osborn wrote in 1897:

My study of teeth in a great many phyla of Mammalia in past times has convinced me that there are fundamental predispositions to vary in certain directions; that the evolution of the teeth is marked out beforehand by hereditary influences which extend back hundreds of thousands of years.—*Science*, Oct. 15, 1897.

The subject is further elaborated by the same author in the *American Naturalist*, April, 1902, and I have offered some theoretical considerations in *Nature*, Dec. 28, 1905, p. 197.

It remains to offer some remarks on the probable age of the Florissant shales. I am informed that geology affords little help in this matter, and for the present, we must rely wholly, or almost wholly, on the evidence afforded by the fossils. The total absence, so far, of mammals, reptiles, batrachians or land shells is much to be regretted; it can hardly be doubted that further search will reveal some members of one or other of these groups. In the meanwhile, it ought to be possible to reach some conclusions from the very large series of organisms already discovered.

In the first place, it seems to me evident that we must cease to refer to the Florissant shales as belonging to the "Green River Group," unless that term is so extended as to be nearly meaningless. Mr. Scudder wrote in 1893:

The detailed study of the fossil Rhynchophora has made very clear and specific one point which impressed me in general while working in the field, and that is the wide difference between the character of the fossils obtained at Florissant and those obtained at any of the other localities (perhaps excepting Elko, Nevada, of which little is known) in the Rocky Mountain region. He goes on to specify the differences in detail, and remarks that when we come to examine the species of Rhynchophora, we shall find that while the three localities in western Colorado and Wyoming share a number of forms in common not a single species found at Florissant occurs in either of the others.

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Mr. Scudder designates the Florissant fauna as the *Lacustrine Fauna*, and the other (including the Green River beds) as the *Gosiute Fauna*, and then proceeds:

> The difference between the Gosiute and Lacustrine faunas is shown to be much more remarkable when we examine the larger groups. Thus, of the 66 genera found at Florissant, only 18 occur also in the Gosiute fauna, which contains, besides, 31 genera not found at Florissant, and there are even a number of tribes which, as far as we yet know, are entirely confined to one or the other fauna.

Mr. Scudder does not attempt to decide which is the older.

Turning now to the fishes, the Perciform fishes have five genera, with 18 species, in the Green River beds, but one genus at Florissant, different from all the Green River ones. The Cyprinids have a genus with several species at Florissant, but no member at all in the Green River. The Isospondyli are not at Florissant, but have three Green River genera, one allied to *Clupea*. There is even a ray (*Dasyatis*) in the Green River beds. While the Florissant fish-fauna is so small and localized that the absence of particular types cannot be considered very important, the *presence* of types not known in the Green River beds is certainly significant. The evidence from the plants is not so clear, but there is no very close similarity. The presence of an undoubted palm and of a *Cinnamomum* in the Green River beds suggest a warmer climate than that of the Florissant flora.

So far as we may judge from the trend of the evidence, and the opinions of Lesquereax and Cope the Florissant beds are *later*, not earlier, than those of Green River. Scudder (1890), after carefully reviewing the subject, concluded that they belonged "in or near the Oligocene." More recent writers have been inclined to reject the Oligocene as a division of our Tertiary, and have referred the Florissant beds to the Upper Eocene. My own feeling is, that Lesquereux's early conclusion was correct, and that they are surely Miocene. Many of the plants are similar to, or even apparently identical with, those well-known to belong to the Miocene period; and that they do not show more resemblance to those of the Pacific region Miocene may be explained as the result of geographical remoteness and a mountain habitat. On the other hand, the resemblances to the plants of older

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periods are generally such as run through the entire Tertiary series, or, in certain cases, due to mere mistakes. Lesquereux, being most familiar with fossil floras, made comparison with them, but the more one works upon the plants, the more one is impressed with their modern *facies*, and in many instances with the extremely close resemblance to types still living in the Rocky Mountains.

That the deposits are not *later* than Miocene, will be generally admitted; for in spite of all resemblances to recent forms, there are plenty of proofs that a long time has elapsed since the deposits were formed. Indeed, argument from this side of the case would be superflous. With regard to the climate prevailing when the Florissant biota lived, it may be said that it was undoubtedly moister and warmer than that of the present day. As has been several times remarked, it seems to have resembled that of our southern states; but not, I think, the most southern ones. We do not know what elevation of the range may have taken place since the Florissant epoch; but it may be doubted whether the warmer climate was wholly or primarily due to a lower altitude, for it is well known that the whole continent enjoyed mild or warm temperatures during the Miocene, even far north.[1] Having in view the known Miocene flora of the lowlands in this latitude, it certainly appears that that of Florissant was semialpine or boreal in character; especially since a critical examination of the material and literature indicates that several of the apparently subtropical species are wrongly credited to it, or are very doubtfully of the genera to which they have been assigned. Even some of the apparent exceptions confirm the view just stated. Thus *Weinmannia*, today a neotropical genus, is represented by excellent material at Florissant; but on turning to Grisebach's *Flora of the British West Indian Islands*, I find that *Weinmannia* in Jamaica is "common on the summits of the Blue Mountains," one of the specific names applied to it being *alpestris*. It is, therefore, a mountain genus, which once lived in the Rocky Mountains, and may even have survived there until destroyed by the cold of the glacial epoch.

If the above arguments are justified, it is easy to understand why so many of the Florissant plants, notwithstanding their antiquity,

[1] For a general discussion of this matter, see A. R. WALLACE'S *Island Life*.

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resemble those of the present day. During the Miocene, the lowlands were occupied largely by a flora which has not been able to survive the later cold, and has either been exterminated or driven into Central America. But in the mountains, the temperate region flora must have maintained itself, restricted in area, but ready in a later day to spread widely over the country. Hence assuming the Florissant beds to be Miocene, their plants might show more similarity in many respects to those of today, than to the strictly contemporaneous flora of the lowlands in the same latitude.

It is true that Scudder refers a number of times to subtropical affinities exhibited by the Florissant insects, but on the *whole* the insect fauna is that of a warm temperate region; and certainly the bees, which I have studied, are by no means of tropical groups. The prevalence of Aphides indicates a temperate region, while many of the genera in other groups are such as exist in the United States today. The appearance of a small number of species having a really tropical *facies* is explained by the ready migration of insects; and, in truth, such forms exist in the Colorado fauna today, some as permanent residents, others as casual visitors.

It is much to be regretted, that in all the collecting which has been done at Florissant, no record has been kept of the exact horizons from which the specimens came. It may well be that the plants and animals are not the same in all, and that much time elapsed between the formation of some of them. This seems the more probable, from the large number of closely-allied species of certain groups of insects and plants; too many, it would seem, to have existed at the same time and in the same immediate locality. If these could be ascertained to come from different horizons, the difficulty would be explained. There is also reason to hope that by carefully noting the horizons we might determine the *time of year* of the eruptions. Lesquereux has already made some suggestions bearing upon this matter; and it is to be remarked that large numbers of Bibionid flies and winged Termites have been found, indicating by their presence early spring. If we could thus ascertain the time of year of any particular layer, we should know something about the time of flight of the insects entombed

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in it, in addition to those which we could safely assume to be vernal or otherwise. This information would not only be of interest from an entomological standpoint, but would perhaps help to explain the differences between the contents of closely adjacent beds, which might have been deposited at different seasons of the year.

Many specimens have been obtained at Florissant by persons who have no expectation of using them for scientific purposes; or are deposited in collections unworked. The University of Colorado will be very glad to obtain the loan of any such material for study, and will return it carefully; but it is hoped that if any new species are found in private collections, they will be ultimately deposited in some museum where they can be permanently cared for and made accessible to students.

Summary of the Fauna and Flora of the Florissant Shales

BIRDS (2 species)

Order Passeres

Palæospiza bella J. A. Allen, is a passerine bird of uncertain affinities, but regarded as the type of an extinct genus. "The absence of the bill renders it impossible to assign the species to any particular family, but the fossil on the whole gives the impression of Fringilline affinities." (Allen.)

Order Limicolae

Charadrius sheppardianus Cope, is a plover which Cope could not distinguish from the modern genus *Charadrius*. It was discovered by Dr. G. Hambach.

FISHES (9 species)

Order Holostei

Amia dictyocephala Cope, and *A. scutata* Cope, represent a genus which has one living species (*A. calva*, Linné, the Bow-fin) in North America, but is common (six species) in the Bridger Eocene of Wyoming. It appears to represent a waning type.

Order Nemognathi

Rhineastes pectinatus Cope, is a catfish belonging to a genus otherwise known (five species) from the Bridger Eocene of Wyoming.

Order Eventognathi (Plectospondyli)

Amyzon Cope, is a genus of Catostomidæ, or suckers, well represented at Florissant. Three or four species occur, and have been described by Cope.

Order Percomorphi

Trichophanes Cope, a genus of perciform fishes of the family Aphredoderidæ, is represented by *T. foliarum* Cope, and *T. copei* Osborn, Scott and Speir.

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The family has three other genera in the Green River beds of Wyoming, but our genus is not present in those beds, so far as known.

MOLLUSCA (1 recognizable species)

A few freshwater Mollusca have been found, not differing in any striking characters from those inhabiting Colorado today. *Planorbis florissantensis* Ckll. has recently been described; the other forms have not yet been met with in a condition for description. It is much regretted that no land shells have yet been discovered.

INSECTS

COLEOPTERA (213 species described, of over 400 found)

Carabidæ. Scudder reports 25 species.

Dytiscidæ, etc. (water-beetles). Five species.

Staphylinidæ. Thirty-five species.

Nitidulidæ. Three species.

Byrrhidæ. Represented by a remarkable extinct genus, *Nosotetocus* Scudd., with three species, and by four referred to modern genera.

Silphidæ, *Histeridæ*, *Ptinidæ*, *Coccinellidæ*. "From 2 to 10 species each." *Cleridæ*, *Parnidæ and Dermestidæ*, each one species.

Telephoridæ. One species (*Chauliognathus pristinus* Scudd.), referred to a modern genus.

Scarabæidæ. Nearly 30 species.

Cucujidæ, two.

Buprestidæ. "Nearly as many" as in the *Scarabæidæ*. One (*Chrysobothris haydeni* Scudd.) has been described, and is placed in a living genus.

Elateridæ. "Over forty [species] have been separated."

Meloidæ, *Mordellidæ*, *Malacodermidæ*. "About forty species," i. e., of these groups together.

Rhipiphoridæ. *Rhipiphorus geikiei* Scudd.; the genus modern.

Cerambycidæ. "Thirty or more specimens, representing more than half as many species. *Parolamia rudis* Scudd., belonging to an extinct genus, has been described.

Chrysomelidæ. "About two dozen species." One referred to an extinct genus, *Oryctoscirtetes* Scudder.

Tenebrionidæ. "Nearly 20 species."

Bruchidæ. "A dozen or more species." The only one described is placed in the modern genus *Spermophagus*.

Rhynchophora. The species of this great group, commonly known as weevils, have been worked up by Mr. Scudder, with the following results:

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Rhynchitidæ.

Subfam. *Rhynchitinæ.* 4 species, belonging to 3 genera, of which one is extinct.

Subfam. *Isotheinæ.* 11 species, referred to 6 genera, all extinct, the subfamily itself being extinct. One of the genera also occurs in the strata at Roan Mts., Colo., and another genus has been found at Green River, Wyo., the species in each case being distinct from those of Florissant.

Otiorhynchidæ. 14 species, referred to 10 genera, of which six are extinct, but one of these is merely a blanket genus to cover miscellaneous members of this group, the affinities of which are uncertain.

Curculionidæ. 75 species, belonging to 36 genera, of which 9 are said to be extinct. One of the extinct genera, *Geralophus* Scudd., has 9 species, and is the most abundant type of Rhynchophora at Florissant.

Calandridæ. 6 species, representing 5 genera, of which 3 are extinct.

Scolytidæ. 1 species, of the modern genus *Hylesinus.*

Anthribidæ. 5 species, of as many genera, of which two are extinct.

HYMENOPTERA (33 species described,[1] of over 230 found)

Apoidea (bees). 14 species, of 9 genera, of which two are extinct, while one is represented by an extinct subgenus (? genus) placed under *Parandrena.* The modern genera are *Halictus* (2 species), *Andrena* (2), *Dianthidium* (1), *Anthidium* (2), *Ceratina* (1) and *Heriades* (3). The details will shortly be published elsewhere.

Fossores, etc. "About 30 species." I have described 12 wasps, belonging to 10 genera, of which 5 are extinct. The recent genera are *Passalæcus, Hemipogonius, Tracheliodes, Hoplisus* and *Ammophila.* There are two extinct genera of *Tiphiidæ.* I have also described an extinct genus of *Vespidæ,* with 3 species, and two species of *Eumenidæ,* referred to the modern genus *Odynerus.*

Formicoidea (ants). "Perhaps fifty species." They will be studied by Dr. W. M. Wheeler. One species (*Ponera hendersoni* Ckll.) has recently been described.

Ichneumonidæ "perhaps 80" species.

Stephanidæ. I have described one, belonging to a new genus.

Braconidæ, Chalcididæ, Cynipidæ, Chrysididæ. "Probably 50 species" between them.

Tenthredinoidea. "14 or 15 species. One, *Atocus defessus* Scudd., has been published; it represents an extinct genus belonging to the *Lydidæ.*

Siricidæ. One.

LEPIDOPTERA (9 published, of perhaps 16 found)

Rhopalocera (butterflies)

[1] Of these, 31 await publication. The large one referred to by Scudder as apparently a *Bombus* is not sufficiently well presented for identification, but it is not a bee, and probably belongs to the Coleoptera.

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Fam. *Nymphalidæ*.

Subf. *Nymphalinæ*. 5 species, of as many genera, all extinct.

Subf. *Libytheinæ*. 2 species, of two genera, both extinct.

Papilionidæ, s. f. *Pierinæ*. 1 species, of an extinct genus.

Heterocera (moths). "Perhaps 8 species;" one has been described by Scudder, and is referred, with doubt, to the modern genus *Psecadia*. I have examined a small species, probably one of the *Elachistidæ*, collected by Scudder.

DIPTERA (54 described; many more found)

Culicidæ, *Chironomidæ*. "Abundant."

Tipulidæ. 51 species described by Scudder; they belong to 15 genera, of which 8 are extinct. No less than 15 species are referred to the modern genus *Tipula*.

Mycetophilidæ. "Probably 20 or 30 species." One has been published, typical of an extinct genus, *Mycetophætus*, Scudder.

Bibionidæ. Very abundant in individuals, but apparently few species.

Stratiomyidæ. "2 or 3 species."

Hirmoneuridæ. One has been described, representing an extinct genus, *Palembolus* Scudd. Others belong here or to *Mydasidæ*.

Asilidæ, *Therevidæ*. Quite numerous.

Bombyliidæ. "Certainly 6 or 8 species."

Syrphidæ. Numerous. Discussed by Dr. Williston.

Empidæ. Numerous.

Ortalidæ. 3 or 4 species.

Œstridæ. One species described, belonging to an extinct genus, *Paloestrus* Scud.

Muscidæ and allies. Very many.

ORTHOPTERA (24 species)

Blattidæ. 2 species, referred to living genera.

Forficulidæ. 10 species, belonging to a single extinct genus, *Labidiuromma* Scudd.

Phasmidæ. One species, of an existing genus.

Acridiidæ.

Subf. *Œdipodinæ*. 3 species, including two extinct genera, and the modern genus *Œdipoda*, here only used in the old and general sense.

Subf. *Truxalinæ*. 3 species, two of them belonging to an extinct genus, the third referred quite provisionally to a modern genus. *Tyrbula multispinosa* Scudd., described from Green River, Wyoming, is recorded from Florissant on the strength of a fragmentary specimen. As the insects of the Green River deposits are in general quite distinct from those of Florissant, the identity must be considered very doubtful.

Locustidæ. 5 species, all of different genera, and including four subfamilies. One genus is extinct; two others are quite provisionally placed in modern genera.

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HOMOPTERA (80 species)

Coccidæ. One, considered to be a male of the still existing genus *Palæococcus*.

Aphididæ. All the genera extinct.

Subf. *Aphidinæ*. 24 species, placed in 11 genera.

Subf. *Schizoneurinæ*. 6 species, referred to 4 genera.

Psyllidæ. 2 species, belonging to two extinct genera.

Fulgoridæ (sens. latiss.) 13 species, of 7 genera, of which three are extinct, and three others are only provisionally employed.

Cicadidæ. One species, placed in the modern genus *Cicada*.

Jassidæ (sens. lat.). 11 species, of 8 genera. Two genera are described as extinct; 3 modern genera are only provisionally or doubtfully recognized.

Cercopidæ. 22 species, placed in 9 genera, of which six (including the most abundant and characteristic species) are extinct. One of the modern genera is only provisionally employed. The extinct genus *Petrolystra* includes a couple of very large species, having the tegmina 29½ and 28¼ mm. long respectively.

HETEROPTERA (140 species)

Corixidæ. 3 species, of 2 genera, one extinct.

Notonectidæ. 1 species of the modern genus *Notonecta*.

Veliidæ. 2 species, of 2 genera, both extinct.

Hydrobatidæ. 1 species, of an existing genus.

Reduviidæ. 2 species, representing 2 genera, both extinct.

Tingididæ. 3 species, of 3 genera, one of them extinct.

Capsidæ. 13 species, of 7 genera, only one described as extinct.

Lygæidæ. 49 species, placed in 24 genera, of which 16 are extinct. Two of the species are Pyrrhocorids, referred to the modern genus *Dysdercus*. From the figures, it seemed to me that *Necrochromus cockerelli* Scudd., might belong to the Phymatidæ, but Prof. Herbert Osborn, whom I consulted about the matter, thinks it is probably a true Lygæid.

Coreidæ. 33 species, referred to 14 genera, 10 extinct.

Peniatomidæ. 33 species, of 14 genera, 13 extinct.

EPHEMEROPTERA (six nominal species)

Ephemeridæ. One species described from a poorly preserved adult, and five from nymphs; all referred, in a general sense, to *Ephemera*. The nymphs have characters of various genera; *E. immobilis* suggests *Baetis; E. tabifica* has some resemblance to *Potamanthus; E. macilenta* recalls *Hexagenia; E. pumicosa* and *interempta* may be related to *Ephemerella*.

NEUROPTERA (12 species)

Chrysopidæ. 4 species, belonging to 2 extinct genera.

Hemerobiidæ. 1 species, of the existing genus *Osmylus*.

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Panorpidæ. 2 species, of different genera, one of which is extinct.
Raphidiidæ. 5 species, referred to the only two existing genera.

ODONATA (9 species)

Æschnidæ. 3 species, referred to Æschna; one is a nymph. *Æ. separata* is said to belong to the subgenus *Basiæschna;* this group is now recognized as a genus, so the species will be *Basiæschna separata*.
Agrionidæ. 6 species, one a nymph. Three genera are recognized, of which one is extinct.

PLATYPTERA (6 species)

Termitidæ. 6 species, in 3 genera, one extinct.

TRICHOPTERA (22 species)

Hydropsychidæ. 16 species, in 7 genera, of which 5 (one of them containing 7 species) are extinct.
Leptoceridæ. 2 species, provisionally placed in the modern genus *Setodes*.
Limnophilidæ. One species, provisionally referred to the existing genus *Limnophilus*.
Phryganidæ. 3 species, of as many genera, one of which is extinct.

THYSANURA (1 species)

Lepismatidæ. One species, of the recent genus *Lepisma*.

BALLOSTOMA (1 species)

Planocephalidæ. Including *Planocephalus aselloides* Scudder, a problematical animal of uncertain affinities. Scudder makes the Ballostoma a suborder of Thysanura.

ARACHNIDA

ARANEÆ (spiders) (30 species)

In the nature of things, it is difficult to classify fossil spiders. Many years ago, Mr. R. I. Pocock expressed to me his dissent from some of the references to genera, etc., made by Scudder; but not being at that time especially interested in the Florissant fossils, I did not learn what changes he would make.
Agalenidæ. Two species, referred to a modern genus.
Attidæ. 3 species, placed in the extinct genus *Parattus* Scudd.
Drassidæ. 5 species, placed in two modern genera.
Dysderidæ. 1 species, of a modern genus (*Segestria*).
Epeiridæ. 12 species, in 4 genera, one genus (with 4 species) being extinct. There is one species of *Nephila*.
Theridiidæ. 3 species, and egg-cases referred to a fourth. No extinct genera.
Thomisidæ. 3 species, referred to *Thomisus* in a broad sense.

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SPERMATOPHYTA

DICOTYLEDONES (about 125 species)

Compositæ (1 species)

A thistle, *Carduus florissantensis* Ckll., has been described from a specimen collected by Judge Henderson and Dr. Ramaley.

Convolvulaceæ (2 species?)

Two "scariose calyxes" are described by Lesquereux as belonging to the genus *Porana*, which has several species in the European Miocene, and one in the John Day Miocene of Oregon.

Apocynaceæ (1 species?)

Apocynophyllum scudderi Lx., was described from the Green River beds of Wyoming; but Kirchner lists it from Florissant, on the strength of a specimen in the collection of Dr. Hambach. No particulars are given, and I think the occurrence of the species at Florissant needs confirmation.

Oleaceæ (8 species)

No less than seven species of *Fraxinus* are described by Lesquereux; but of one it is said that it may be a *Myrica*. Two are unfigured. The leaves described as *Fraxinus libbeyi* are curiously similar to those of *Ulmus braunii*. In addition to the new species, *F. prædicta* Heer is reported, but on the basis of a very unsatisfactory fragment. This species is also said to occur in the Denver beds at Golden. *Osmanthus præmissa* (*Olea præmissa* Lx.) is represented by a beautiful specimen, showing leaves and flowers.

Ebenaceæ (2 or more species?)

Two species represented by leaves, and referred to *Diosypros brachysepala* Al. Br. (originally described from Europe) and *D. copeana* Lx. The first of these appears to be more especially a Laramie species, while the second originally came from the Green River beds in Nevada, and is not cited by Knowlton from any other place. The recognition of these species in the Florissant flora must doubtless be considered wholly provisional. Two other species, *Diospyros cuspidata* Kirchner, and *Macreightia crassa* Lx., are based on calyces. Their value as evidence is clearly very slight, and they possibly represent different interpretations of the same thing.

Sapotaceæ (1 species)

Bumelia florissanti Lx., is described.

Myrsinaceæ (1 species)

Myrsine latifolia Lx., is based on a fragmentary leaf.

Ericaceæ (1 or 2 species)

Andromeda rhomboidalis Lx. is described but not figured. Another leaf is referred, quite hypothetically, to *Vaccinium reticulatum* Al. Br.

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Araliaceæ (2 species)

Aralia dissecta Lx. is based on a very large leaf, not at all resembling the ordinary species of the genus. *Hedera marginata* Lx. is a species of somewhat doubtful generic position.

Malvaceæ (1 species)

Malvastrum exhumatum Ckll. has been based on a specimen in the collection of the University of Colorado. It resembles a species living in New Mexico.

Sterculiaceæ (1 or 2 species)

Sterculia rigida Lx. and *S. engleri* Kirchner have been described. They do not appear to differ materially.

Tiliaceæ (1 species)

Tilia populifolia Lx. is a species with fine large leaves.

Rhamnaceæ (5 or 6 species)

Six species are described, as *Paliurus florissanti* Lx., *P. orbiculatus* Saporta, *Rhamnus kirchneri* Ckll.,[1] *R. notatus* Saporta (?), *R. oleæfolius* Lx., and *Zizyphus obtusa* Kirchner.

The species of Saporta were originally described from Europe, and their recognition at Florissant is provisional.

Sapindaceæ (5 or 6 species)

Lesquereux has described five species of *Sapindus;* and a fruit is referred with doubt to *Dodonæa.*

Aceraceæ (1 or 2 species)

Kirchner describes *Acer florissanti* from an excellently preserved leaf, and *A. mysticum* from a fruit. They may very well belong to the same species, of course. A leaf of *A. florissanti* was found southwest of Florissant by Messrs. Henderson and Ramaley.

Staphyleaceæ (1 species)

Represented by *Staphylea acuminata* Lx.

Ilicaceæ (6 species)

Lesquereux has described six species of *Ilex;* Kirchner adds a seventh, *I. rigida,* but it appears to me to be a synonym of *I. knightiæfolia* Lx. *Ilex quercifolia* Lx., 1883, not of Meerburgh, 1798, may be called *I. leonis.*

Celastraceæ (4 species)

Lesquereux describes *Celastrus fraxinifolius* and *C. lacoei,* and records *C. greithianus* Heer, a European species. Another form is named *Celastrinites elegans* Lx.

Anacardiaceæ (11 species)

Ten species of *Rhus* were described by Lesquereux, and Kirchner adds another, *R. rotundifolia.* These include typical *Rhus* (*R. coriarioides*), *Schmaltzia* (*S. vexans*) and *Cotinus* (*C. fraterna*).

[1] *Rhamnus kirchneri* Ckll. = *R. ellipticus* Kirchner, 1898, not *R. elliptica* Swartz, 1788.

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Rutaceæ (1 species)

Zanthoxylum spireæfolium Lx., does not look, from the figure, as if it belonged here, but it may do so. It is said to be closely allied to certain fossil species described by Heer from Europe.

Leguminosæ (7 species)

Lesquereux described seven species, referred to the genera *Acacia*, *Cercis*, *Cytisus*, *Leguminosites*, *Mimosites* and *Podogonium;* while he recognized species of *Dalbergia* and *Cassia* described by Heer. *Podogonium americanum* Lx., is listed by Kirchner, but apparently in error; it is a species of the Laramie and Montana formations in Wyoming. *Cercis parvifolia* Lx., was found by Messrs. Henderson and Ramaley in the railroad cut east of Florissant station. The Florissant *Dalbergia* resembles the living *D. melanoxylon* G. and P. which I have received from Ceylon, through the kindness of Mr. E. E. Green. *Mimosites linearis* (Lx.) Knowlton, has a curiously strong superficial resemblance to *Dalbergia purpurea*, but the type of leaf is a common oue.

Rosaceaeæ (6 species)

Rosa hilliæ Lx., is a very interesting trifoliate species. The genus *Amelanchier* is represented by *A. typica* Lx. and *A. scudderi* Ckll. *Amygdalus* is represented by *A. gracilis* Lx., reported also from the Green River beds of Wyoming; but Lesquereux figures leaves from both localities, and they no not appear to me to belong to the same species. *Cratægus* has two species, *C. lesquereuxi* Ckll.,[1] and *C. flavescens* Newberry. The latter is also reported from the John Day Valley, Oregon.

Altingiaceæ

Liquidambar europæum Al. Br., a common Miocene plant of Europe, is listed by Knowlton and Kirchner from Florissant, and is also reported from the John Day Miocene. There is apparently some mistake, however, as Lesquereux cites it from Wyoming, not from Florissant, and Knowlton omits this locality, while giving no other source of information.

Cunoniaceæ (3 species?)

Lesquereux describes three species of *Weinmannia*. They certainly look different; but the common neotropical species of today, *W. pinnata*, must be very variable as it has received seven specific and three varietal names.

Magnoliaceæ

Kirchner refers here certain fruits described by Lesquereux, but there is no real evidence that the family was represented at Florissant. *Carpites milioides* Lx., looks like a *Lepidium*.

[1] *Cratægus lesquereuxi* Ckll.=*C. acerifolia* Lx., 1883, not of Moench, 1785.

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Polygonaceæ (1 species)

Dr. Small has described a species as *Polygonum tertiarium*. I saw the type at the New York Botanical Garden.

Pimeleaceæ (1 species)

Pimelea delicatula Lx., is described.

Proteaceæ (8 species)

Certain seeds are described as *Banksites lineatus* Lx., while Lesquereux describes seven species ascribed to *Lomatia*, some of them looking very like Hydrophyllaceæ of the *Phacelia* type;—thus, compare *L. terminalis* and *L. tripartita* with *Phacelia bipinnatifida*, *L. acutiloba* with *P. franklinii*, or *L. spinosa* with *P. fimbriata*.

Santalaceæ (1 doubtful species)

Santalum americanum Lx. is a leaf with little character; it might just as well be a *Leparg yræa*.

Moraceæ

Kirchner cites two species of *Ficus*, but one of them (*F. haydenii* Lx.) is a Laramie species, while the other, also a Laramie species, was reported from Florissant only on the strength of a fragment collected by Professor Cope; which, from the figure, does not seem to be identical with the Laramie plant, though it looks like a *Ficus*. Kirchner has figured a leaf from Florissant, which he refers to *Ficus haydenii*, but it cannot possibly have anything to do with that species. Messrs. Henderson and Ramaley found a leaf which has the appearance of *Cinnamomum*. It is not "*C. scheuchzeri*" (Lx., Cret. and Tert. Fl., pl. xxxviii. f. 6), but I cannot separate it from certain leaves attributed to *C. affine* by Lesquereux. Knowlton, however, divides *C. affine* into two species, and by the characters he assigns, the Florrissant leaf would belong to *Ficus trinervis* Knowlton.

Ulmaceæ (6 species)

Planera longifolia Lx. and its variety *myricæfolia* are very abundant; Lesquereux examined over 2,000 specimens. A *Celtis* has been named *C. McCoshii* Lx.; it is said also to occur in Uinta County, Wyoming. Of Ulmus there are supposed to be four species; one is considered to be *U. braunii* Heer, a common species of the European Miocene; the others were described as new. *U. brownellii* looks to me too much like *U. hilliæ*, but Lesquereux points out differences.

Betulaceæ (about 3 species)

Alnus cordata Lx. is described but not figured. A fragment from Florissant is referred to *A. kefersteinii* (Goepp.) Ung. *Betula* is represented by two species.

Salicaceæ (6 species)

Populus has several species. A narrow-leafed cottonwood is *P. lesquereuxi* Ckll. (*heerii* Lx., not Saporta); the specimens are beautifully preserved. *P. scud-*

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deri (*P. balsamoides* (?) *latifolia* Lx.[1]) has very large broad leaves; of the same general type, but smaller, more obtuse, and with different veining, is *P. arctica* Heer, which Kirchner lists from Florissant, but probably in error. Knowlton, however, says it is abundant from the Laramie to the Miocene; no doubt the name has been used to designate leaves of this type, which may or may not be conspecific. *P. pyrifolia* Kirchner, and *P. oxyphylla* Sap., Lx., probably represent large and small leaves of the same species. In view of the general improbability of our species being identical with that of Saporta, I should prefer to use Kirchner's name. Still another species, represented by leaves not unlike the smaller and shorter ones of *P. lesquereuxi*, is referred to *P. zaddachi* Heer, but is said not to be typical.

Of *Salix*, Lesquereux has described *S. libbeyi* and *S. amygdalæfolia*, the latter also said to occur in the John Day Miocene. Kirchner lists four others, but they represent obsolete or dubious identifications. A fine leaf of an apparently new species was found by Messrs. Henderson and Ramaley.

Myricaceæ (about 10 species)

Comptonia is represented by *C. insignis* (*Myrica insignis* Lx.) and *C. acutiloba* (*Myrica latiloba acutiloba* Lx.); the latter I should think merely a small leaf of the former, except that the veining does not seem quite the same. Two species, described as *Myrica*, can be segregated under *Morella*, following Dr. Small. These are *Morella hendersoni* (Ckll.), based on an excellent specimen secured by Messrs. Henderson and Ramaley, and *M. bolanderi* (*Myrica bolanderi* Lx., 1878; *Ilex undulata* Lx., 1874, not of Heer, 1859). The locality of the latter is not entirely without doubt.

There remain, still in *Myrica*, six species described by Lesquereux, and four others recognized as pertaining to species described from Europe by Unger, Saporta and Schimper. Judging from the figures, I should think that *M. fallax* Lx., *M. obscura* Lx., and *M. rigida* Lx., might very well represent variations of *M. drymeja* (Lx.) Knowlton; Lesquereux suggests this possibility in regard to *fallax*. *M. scottii* Lx., is very like the narrower *Planera* leaves, but the venation differs. *M. amygdalina* Sap., Lx., is perhaps too near *M. acuminata* Ung., Lx., *M. polymorpha* Schimp., Lx., exceedingly like *M. scotti*. *M. zachariensis* Sap., is figured both from Florissant and Alkali Station, Wyo., but the figures seem to me to represent different things.

Juglandaceæ (4 or 5 species)

An involucre, not figured, is referred to *Engelhardtia oxyptera* Saporta. *Hicoria juglandiformis* (Sternb.) Knowlton, a species described from Europe, is recognized from good specimens of the leaves; it is also reported from the Miocene of California. Two others European species are hypothetically recognized from nuts. Of *Juglans* we have *J. affinis* Kirchner, *J. florissanti* Lx. (not figured)

[1] The name *latifolia* was earlier (1794) employed in this genus by Moench, for a tree now considered a variety of *P. balsamifera*.

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and a form which is referred to the European *J. costata* Ung. In addition, Kirchner lists *J. thermalis* Lx., and *J. crossii* Knowlton. Of these, the former belongs to the Denver beds (Golden etc.,) and has apparently never been found at Florissant; while the latter, heretofore reported from Wyoming and Montana, is recognized in a Florissant specimen which is figured, and certainly looks like *crossii*. It is to be remarked that *J. crossii* is a substitute name for *J. denticulata* Heer, preoccupied; hence it belongs to the European plant, not to the American, should the two be really distinct.

Pterocarya americana Lx., seems doubtful as to locality, and Lesquereux himself says "it would be more advisable to consider the fragment as that of a leaflet of *Carya* or of *Juglans*."

Cupuliferæ (about 10 species)

Of *Carpinus* we have *C. fraterna* Lx. and C. *attenuata* Lx. A greatly elongated leaf of *C. fraterna* was found by Messrs. Henderson and Ramaley; the allied modern *C. americana* exhibits a similar variation. In addition, *C. grandis* Ung., is reported; but the figures appear to indicate that the Florissant leaves so-called are *fraterna*, and are quite distinct from the plant from Elko Station, Nevada, referred to *C. grandis*, or probably more correctly called *C. elkoana* (*Quercus elkoana* Lx.)

Castanea intermedia Lx., is listed by Kirchner from Florissant; Lesquereux and Knowlton say Middle Park. *Ostrya betuloides* Lx. is described, but not figured.

Of *Quercus* we have *Q. ramaleyi* Ckll., allied to a recent species of New Mexico; *Q. pyrifolia* Lx.; *Q. osbornii* Lx., having a curiously close resemblance to *Rhus acuminata;* and *Q. elænoides* Lx., also occurring in the Miocene of California. The last is, I suppose, the plant reported in 1883 as *Q. elæna* Ung. The following European species are also recognized, but the first two, at any rate, are doubtful: *Q. neriifolia*, Al. Br., *Q. drymeja* Ung., *Q. mediterranea* Ung., and *Q. serra* Ung.

MONOCOTYLEDONES (about 5 species)

Palmæ

An object something like a hazel nut is described as *Palmocarpon* (?) *globosum* Lx., its connection with the palms is quite hypothetical. *Flabellaria florissanti* Lx., a genuine palm, is not from Florissant, notwithstanding its name. It is from the Green River beds of Wyoming, and suggests that the Green River period had a warmer climate than that of Florissant.

Lemnaceæ (1 species)

Lemna penicillata Lx. =*Spirodela penicillata*.

Araceæ (1 species)

Acorus affinis Lx., afterwards referred to *A. brachystachys* Heer, is a rather dubious plant.

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Typhaceæ (1 species)

A *Typha* is very common at Florissant, and is described and figured by Lesquereux (Cret. and Tertiary Floras, p. 141, pl. XXIII) as *T. latissima* Al. Br., of Europe. It is admitted, however, that it does not exactly agree with the European plant, the "veinlets which separate the primary nerves" being twice as numerous. It is preferable, I think, to distinguish the Florissant plant by another name, and *Typha lesquereuxi* is proposed. Lesquereux cites Florissant and the Green River beds of Wyoming (under the name of "Randolph County"); the former should be considered the type locality.

Naiadaceæ. (1 or 2 species?)

The objects called *Najadopsis rugulosa* Lx., *Potamogeton* (?) *verticillatus* Lx., and *P. geniculatus* Al. Br. are of a problematical character. The last, not figured from Florissant, seems to have the best standing.

GYMNOSPERMAE (4 species)

Pinus florissanti Lx.

From Fossil Stump Hill (Henderson and Ramaley) are excellent specimens of the leaves, not massed together, but separately in bundles of three. These evidently belong to *Pinus hambachi* Kirchner; but since they are exactly the leaves which ought to belong to *P. florissanti*, a species allied to *P. ponderosa*, and known only by the cone, I treat *hambachi* as a synonym. This, the one clearly-known Florissant pine, is allied to the tree still growing in the same region. "*P. palæostrobus*(?)" must be considered doubtful.

Sequoia affinis Lx.

This is the well-known Florissant species, to which the fossil stumps may doubtless be assigned. The specimens referred to *S. langsdorfii*, with doubt, are supposed to be the same. Much of what has been called *Sequoia* appears to be *Glyptostrobus*.

Taxodium is listed by Kirchner, but apparently does not occur at Florissant *Podocarpus eocenica* Ung. is doubtful in the extreme.

Widdringtonia linguæfolia Lx., is common and well-known; what was formerly called *Thuites callitrina* Ung., becomes *W. linguæfolia gracilis* Lx. The reference of this plant to *Widdringtonia* seems unnecessary, as the material agrees well with the American genus *Sabina*, and should I think be referred to as *Sabina linguæfolia*. The mode of branching suggests *Sabina* rather than *Chamæcyparis*. *Widdringtonia* is an old-world genus. *Glyptostrobus ungeri* Heer (?) is also well-known, and is especially interesting as representing a boreal genus, now surviving in China, and most nearly represented in the modern American flora by *Taxodium*. There is some question about the identity of the Florissant plant; Knowlton refers it to *G. europæus*, of which he considers *ungeri* a variety. It ranges, hypothetically, from the Fort Union beds to the Miocene.

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PTERIDOPHYTA

Isoetaceæ (1 species)

Isoetes brevifolius Lx. is described but not figured. It is said to resemble *I. braunii* Heer.[1]

Filices (2 species)

Two ferns have been found; *Sphenopteris guyottii* Lx., which is common, and *Adiantites gracillimus* Lx. The *Sphenopteris* has the aspect of *Asplenium filix-foemina* (L.) Bernh. *Asplenium crossii* Knowlton, has been listed from Florissant in error.

There have also been described a doubtful *Chara;* two supposed species of *Salvinia*, one considered wholly doubtful, the other referred by Hollick to *Tmesipteris;* three problematical mosses, ascribed to *Hypnum* and *Fontinalis;* and some flowers, fruits, etc., of uncertain relationships.

EXPLANATION OF PLATE

The plants figured were all collected by Judge Junius Henderson and Professor Francis Ramaley, and are in the University of Colorado Museum. Descriptions of the new species are included in a paper in *Bull. Torrey Botanical Club*, 1906.

(1) *Quercus ramaleyi*, n. sp., a species of oak closely allied to *Q. fendleri*, still living in New Mexico, of which a leaf is also shown. The leaf of *Q. fendleri* is from Las Vegas Hot Springs, N. M., alt. 7,000 ft.

(2) *Carpinus fraterna* Lx., a species of hornbeam, very closely allied to *C. caroliniana*, living today from Nova Scotia to Texas, in moist localities. The leaf shown is very much more elongate than Lesquereux's type, but the living species varies in a similar manner.

(3) *Amelanchier scudderi*, n. sp., a june-berry or service berry, allied to *A. alnifolia*, living today over a great part of North America. The leaf also resembles the genus *Malus* (apple), and it is impossible to be absolutely sure that it does not belong there, in the absence of other parts; but it is so like *A. alnifolia* that it is almost certainly a close relative.

(4) *Rhus coriarioides* Lx., a sumac scarcely differing from the common living *R. hirta*.

(5) *Malvastrum exhumatum*, n. sp., a star-mallow closely allied to a species found today in New Mexico.

(6) *Carduus florissantensis*, n. sp., a thistle which greatly resembles the scarlet oak, *Quercus coccinea*, but is distinguished by the venation. It is perhaps somewhat allied to the living *C. ochrocentrus* of Colorado, but that has the leaf-surface much more reduced, and the prickles much more developed, as might be expected from the present much greater aridity of the climate.

(7) *Myrica* (or *Morella*) *hendersoni*, n. sp., a wax-myrtle closely allied to the living *M. cerifera*, which occurs in damp places from Maryland to Texas.

[1] *I. braunii* Durieu, 1864, is later, and should be renamed.

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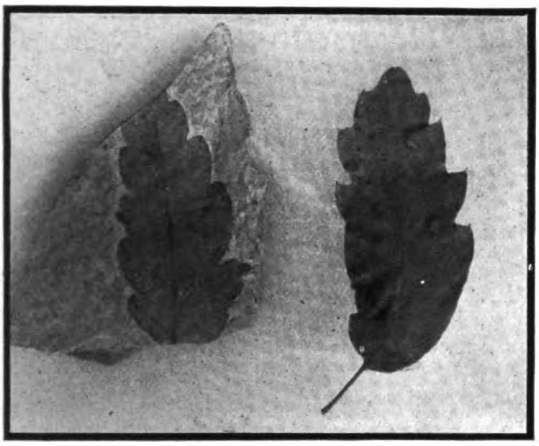

FIG. 1

FIG. 2

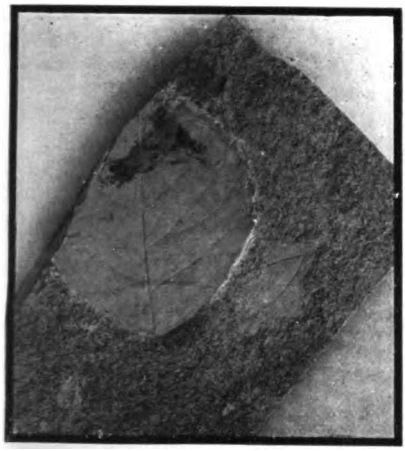

FIG. 3

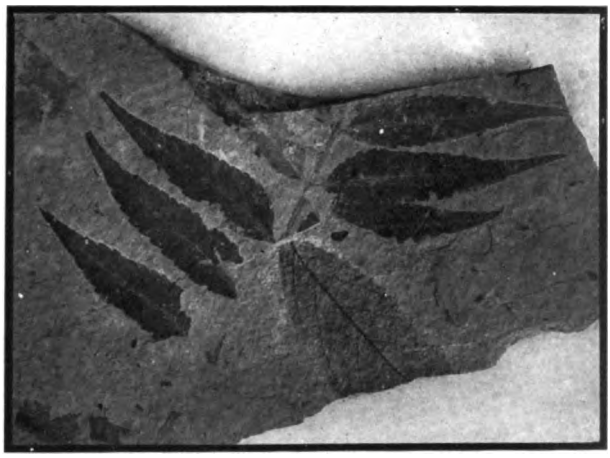

FIG. 4

FIG. 7

FIG. 6

FIG. 5

FOSSIL PLANTS FROM THE FLORISSANT SHALES

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PLANTS OF THE FLORISSANT REGION IN COLORADO [1]

By Francis Ramaley

The vicinity of Florissant, Colo., is a region of considerable botanical interest. It offers a good example of a xerophytic[2] flora at high altitude. To those who live in Colorado, or in other Rocky Mountain states, the plants in general would be familiar, yet there are some plants of striking appearance which do not extend even to northern Colorado.

The present paper is not intended as a contribution to knowledge, but is merely an attempt to describe the general aspect of the region as affected by the plant life. Whoever stops to think of the scenery of any country will probably think first of mountains and seas. Yet for the scenery of everyday life the plant population is very important. A region green with abundant carpet of grasses and herbs has a very different aspect from one which is timber-clad or one which is gray with sage-brush. A person who tramps over the hills or along the stream-banks will find the landscape ever changing with the different plants which he encounters.

In the following pages are described some of the more salient features which give botanical interest to the Florissant region. The half-tone reproductions are all made from the author's negatives, selected to show the larger landscape features, and also a few of the more interesting species in greater detail. As the writer's visit was made in late July and early August, the account will refer to plants seen at that time.

The town of Florissant is situated at an altitude of about 8,000 feet above sea-level in the basin of a Tertiary lake. It is about forty miles west of Colorado Springs and is reached by the Colorado Midland railway. A creek flows westward through the town, receiving

[1] It is intended that this popular account of the plants in the Florissant region will be supplemented later with a more detailed description.

[2] ξηρος, "dry;" φυτόν, "plant."

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tributaries from the north and south. It carries the waters to the South Platte River about five miles to the west. In the summer there is very little water in the streams. Eastward, above the town, is Florissant canyon, through which the main creek flows.

In following up any of the tributaries of Florissant Creek[1] there will be found places with a considerable accumulation of humus soil and a plant covering of mesophytic[2] character. Here and there are stretches of boggy ground where hydrophytes[3] find a suitable substratum. But if we take it all in all, we find a dry-country vegetation throughout the Florissant district.

A botanist does not need to be told that the town of Florissant has been in existence for some years. The weeds along the railroad track and in the roadways and through the pastures tell the story. A considerable number of these weeds have been introduced from lower altitudes since the settling of the country by man. Various plants of the aster, mustard, spurge, smart-weed, and grass families are especially conspicuous as roadside weeds.

An examination of the plant population of the Florissant region shows a great number of plants of the aster or composite family. In fact, during midsummer the prevailing color of the landscape is greenish yellow, due to the many coarse composites which are coming into blossom at that time.[4] A great preponderance of composites is to be noted throughout Colorado, but especially in the south.

[1] Otherwise known as Twin Creek.

[2] μέσος, "middle;" φυτόν, "plant;" i. e., plants growing in conditions of medium dryness.

[3] ὕδωρ, "water;" φυτόν, "plant."

[4] The following plants of the composite family were collected. Determinations were made by Professor Aven Nelson.

Achillaea lanulosa Nutt.
Antennaria parvifolia Nutt.
Artemisia borealis Pall.
Artemesia canadensis Michx.
Artemisia frigida Willd.
Carduus acaulescens (A. Gray) Rydb.
Carduus ochrocentrus (A. Gray) Greene.
Chaenactis douglassii (Hook.) H. & A.
Chrysopsis resinolens Aven Nelson.
Chrysothamnus sp.
Crepis runcinata (James) T. & G.
Erigeron canus A. Gray
Erigeron sp.
Helianthella parryi A. Gray
Helianthus petiolaris Nutt.
Lygodesmia juncea (Pursh) D. Don.
Machaeranthera varians Greene
Picradenia floribunda utilis Ckll.
Picradenia ligulaeflora Aven Nelson
Rudbeckia flava Moore
Senecio bigelovii A. Gray
Senecio eremophilus Richards.
Senecio spartioides T. & G.
Solidago decumbens Greene
Solidago missouriensis Nutt.

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Florissant has a drier and warmer climate than have the parks of northern Colorado, so we find there a number of plants which, in the northern part of the state, do not reach such an altitude. It is interesting to make comparison of Estes Park, in northern Colorado, with Florissant. The two places have somewhat similar topography, are about the same altitude, and yet show many differences in their plants. One of the striking plants about Florissant is the Rocky Mountain bee plant.[1] Some fine specimens of this species may be seen along roadsides and in old fields.[2] In the Estes Park region this plant does not reach the high altitudes, though it is very abundant at Lyons, only twenty miles from the park.

* * * * * * * *

As has been said, the great mass of the vegetation is of the arid type. All the lower-lying territory in the lake basin, except along stream-banks, bears dry-country plants. On many a hillside or gentle slope the plants are seen widely scattered, since the dryness of the soil does not permit close massing. So, while in moister places the "struggle for existence" is between plant and plant, here the struggle is between the plant and its lifeless environment.

In the flat, open country nearly all the larger and conspicuous plants are low, shrubby composites. Perhaps the visitor who is not a botanist would hardly think of them as "shrubby," but the lower parts of these plants live from year to year, and the general habit of the plant is that of a shrub rather than an herb. Here are various kinds of sage-brush.[3] In places where cattle and horses have not trampled the vegetation, or on old wagon tracks, these grayish plants form a striking element of the landscape. None of the large, bushy sage-brushes occur in the Florissant region. An abundance of the smaller ones, however, tells us of the dryness of the soil, which the people of the west associate in their minds with these plants.

The Colorado rubber plant[4] is abundant with other plants of the same general appearance. From the latex, or juice, of this plant

[1] *Cleome serrulata.*

[2] Shown in the lower right-hand figure in the plate at the end of this article.

[3] *Artemisia* spp.

[4] *Picradenia floribunda utilis.*

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rubber can be made. Whether the plant will be of economic value needs to be determined. The plant grows to a height of from eight inches to two feet, branching abundantly from the root. A non-botanist might think of it as a very poor sort of golden-rod. It produces a number of flower heads, but they are rather small. Most of the other plants growing with this one are also of the composite family. Probably different kinds of *Chrysothamnus* and *Picradenia* are most abundant. But throughout the drier parts of the region the number of different species is few. If one looks around him in this dry region, he will see, within a radius of a hundred feet, perhaps thousands of plants, and yet there may be no more than a dozen different species. This is always the case where environment is austere; only a few forms will be well adapted to withstand the unfavorable conditions.

In our account of these dry-country plants we should not omit the shrubby pepper-grass,[1] a plant of the mustard family. Everyone knows the ordinary pepper-grass of door-yards and roadsides, with its short stems and abundance of small white or greenish flowers, followed by the flat, peppery fruits about an eighth of an inch across. The sweet alyssum of the greenhouses and flower beds is familiar, too. The pepper-grass at Florissant shows similarities to these two plants. It has an abundance of small white flowers and the usual peppery fruits. The plants grow so large that when in full bloom they make a fine appearance. Along old roads and in waste places they are frequently massed in large patches, or they form broad bands flanking the roadway. In fact, they are such a striking part of the landscape in midsummer that the Florissant region without the shrubby pepper-grass would be a very different looking place.

* * * * * * * *

Next in amount after the flat, open country will come the dry hillsides. Here are scattered pines and spruces, interspersed with small groves of white-barked aspen.[2] There is a greater variety of herbaceous plants than in the more open country. This is because there is a greater range of conditions for plant life. Hillsides may slope to east or west or north or south, and they may be cut up by gullies, expos-

[1] *Lepidium fonesii* Rydb. [2] *Populus tremuloides* Michx.

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ing different kinds of soil. So, with less sameness in the environment, will come less sameness in the flora.

In the spring these hills bear larkspurs and vetches; and there are the delicate flowers of the bear-berry, or "kinnikinik,"[1] as it is called in Colorado. Later come the lungwort[2] or "bluebell," and lupines and loco-weeds.[3] Throughout the summer may be found various kinds of beard-tongue,[4] and on dry, gravelly slopes certain "stemless" forms of evening primroses. Some of these have flowers two inches across. The wild geranium[5] blooms through spring and summer among fallen logs and in the partial shade of pine and spruce trees. This plant closely resembles the crane's-bill of our eastern states. The columbo is a tall, straight plant of the gentian family,[6] but with greenish flowers. It has much the form of common mullein. At the heads of gullies the tall, pink Gilia[7] can almost always be found. It seldom occurs elsewhere. Different species of golden-rod grow sparingly among pine trees and aspens on the hillsides.

Although most of the plants of the hillsides are herbaceous, rather than woody, still there are representatives of some woody species here and there. Wherever large rocks are found, with frost cracks, one may expect to find a few shrubs. The thimble berry[8] is fairly common. In early spring this bears a mass of large, white, rose-like flowers. At that season the plant is very attractive. However, the berries which come later are so insipid and so full of seeds that one may well wonder at the taste of the botanist who gave the plant its specific name "deliciosus." Some wild raspberries of good flavor may be found now and then, but they are nowhere abundant. A few of our western choke cherries,[9] and some wild gooseberries and currants, grow on the higher hills and in rocky or shaded places.

A shrub known as mountain mahogany[10] is fairly common on drier parts of the hills. The wood of this species is extremely hard; even in collecting small specimens of the plant for the herbarium a pocket

[1] *Arctostaphyles uva-ursi.* [2] *Mertensia.* [3] Species of *Astragalus* and *Aragallus.* [4] *Penistemon* spp. [5] *Geranium fremontii.* A photograph of some of these plants is reproduced in the plate at the end of this article. [6] *Frasera speciosa* Dougl. [7] *Gilia aggregata.* [8] *Rubus deliciosus* James, *Orcobatus deliciosus* (James) Rydb. [9] *Prunus demissa melanocarpa.* [10] *Cercocarpus parvifolius.*

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knife is hardly strong enough to cut the twigs. On dry slopes, exposed to wind, this plant puts forth great numbers of small, short branches, thus producing a dense, scrubby growth. Although the flowers of the mountain mahogany are small and inconspicuous, the fruits are interesting because of the long tail-like style which grows to a length of two or three inches.

The nine-bark[1] and wax-flower[2] are shrubs which produce conspicuous flowers. It is mostly in rocky-places that these are to be found—seldom on open slopes. Lower down in the foothills these plants occur only in the more shaded situations, as along canyon-walls and in deep gulches. Although the rainfall at Florissant is not much greater than at lower altitudes, yet the smaller amount of evaporation permits plants to grow in more open situations.

Trees are nowhere abundant in the lake basin at Florissant, but there are some good stands of spruce in the higher hills a few miles away. All the lower ridges have a few trees. Most of these are pines[3] and spruces, with here and there a cedar. Low mats of juniper are scattered about, chiefly on the steeper slopes. Aspens may be found in soil somewhat more moist than that which supports the cone-bearing trees. A number of dead aspens of some size are to be seen, but none of the living specimens are at all large. A few years ago there was an invasion of caterpillars. It is stated that the aspen trees, during that year, were again and again stripped of leaves. This caused the death of the trees.[4]

In the aspen groves may usually be found certain species of herbaceous plants not so abundant among the pines and spruces. This

[1] *Opulaster.*

[2] *Edwinia*, or *Jamesia.*

[3] Shown in the photographs reproduced in the plate at the end of this article.

[4] Following is a list of woody plants obtained by the writer. On account of the short time which he was able to give to the collection of plant specimens at the time of his visit to Florissant, the list is by no means complete. However it will give an idea of the more common or striking species.

Arctostaphylos uva-ursi (Linn.) Spreng.
Betula fontinalis Sarg.
Cercocarpus parvifolius Nutt.
Dasiphora fruticosa (Linn.) Rydb.
Edwinia americana (T. & G.) Heller
Juniperus sibirica Burgsdorff
Opulaster intermedius Rydb.
Pinus murrayana "Oreg. Com."
Pinus scopulorum (Englem.) Lemmon
Populus tremuloides Michx.
Prunus demissa melanocarpa Aven Nelson
Pseudotsuga taxifolia (Poir) Britt.
Ribes cereum Dougl.
Rubus deliciosus James
Salix stricta (And.) Rydb.

These determinations were all made by Professor Aven Nelson.

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is to be expected because the aspens occur in the richer and more moist soil, and they furnish shade which is suitable for certain plants. Violets, *Arnica*, the columbine, larkspurs, the false Soloman's seal, and other shade-plants occur here.

* * * * * * * *

Even a short account of the Florissant region should contain some mention of the grasses found there. Of these there are many species, but few individuals of any one kind. Nowhere is there a grass carpet of any size, and the grasses occur almost always in small clumps widely scattered on hillsides and stream banks. As is usual in Colorado, the wheat grasses, wild barley, fescue, grama grass, and bromes are the kinds most abundant, rather than such forms as panic grass and blue grass, which are so widely distributed and so abundant in the eastern United States.[1]

* * * * * * * *

In the Florissant region, as elsewhere in the mountain districts of Colorado, the plant population is of a mixed character. The brilliant sunshine, long continued through the growing season, permits the growth of southern forms and plants of the plains region. At the same time, in shady situations among rocks and on north slopes, it is likely to be cool even in the warmest part of the summer. Thus, northern plants are able to obtain a foothold. On the whole, however, the affinities of the flora are with the South rather than with the North. The flat, open parts of the lake basin furnish conditions suited only to a few species of xerophytic plants, but these are represented by many individuals. Many more species are found on the dry hillsides; but it is only along moist canyon-sides and stream-banks that

[1] Seventeen species of grasses were collected. They have been determined by Professor Aven Nelson. Following is the list:

Agropyron caninum (Linn.) Beauv.
Agropyron dasystachyum subvillosum (Hook.) S. & S.
Agropyron occidentale (Vasey)Shear
Agropyron pseudorepens S. & S.
Agropyron tenerum Vasey
Agropyron spp.
Bouteloua oligostachya (Nutt.) Torr.
Bromus porteri (Coult.) Nash
Bromus porteri lanatipes Shear
Bromus pumpellianus Scribn.
Danthonia parryi Scribn.
Festuca ovina Linn.
Hordeum nodosum Linn.
Koeleria cristata (Linn.) Pers.
Sitanion longifolius J. G. Smith.
Stipa vaseyi Scribn.

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mesophytic conditions are reached. Here only are there plant associations which resemble those of the northeastern United States.

Along the streams, especially the swifter parts of their courses, grow birches[1] and willows. If the word "birch" brings to the mind of the reader thoughts of the paper birch of our eastern and central states, then he will have an erroneous idea of the trees at Florissant. The birches and willows are low trees or shrubs, and they form small thickets. In these thickets grow gentians and various orchids, though never in great numbers. Around the margins of the thickets grow the single-flowered harebell[2] and the star-flowered false Soloman's seal.[3] In this same moist soil are other northern plants, such as the shrubby cinquefoil[4] and western mint,[5] and different species of the sedge and crowfoot families. In the places more open, but still moist, there is a curious wide-spreading thistle.[6] The leaves form a dense rosette on the ground with a spread of two feet or more. No upright stem occurs, and the small flower-heads are partly concealed by the incurved leaves.

To get a proper understanding of the plant population of any region, it is often as useful to know what plants are lacking as it is to know what plants are present. If we compare the Florissant region with the mountain districts of New England or the middle Atlantic states, we shall find many differences. In the Florissant region, and for that matter everywhere in Colorado, there are few trees except cone-bearers. There are no nut-bearing trees. Walnuts, butternuts, hickories, chestnuts, and beeches do not extend into Colorado. Hard maple, elm, and ash are absent, as well as other familiar forest trees of the eastern United States. There are no laurels and rhododendrons in the Colorado mountains. In fact, it is only in flowering herbs that our mountains excel. But these make up for all deficiencies. Brilliancy and abundance of color make the hillsides and canyon-slopes beautiful all summer.

[1] *Betula fontinalis.*
[2] *Campanula uniflora.*
[3] *Vagnera stellata.*
[4] *Dasiphora fruticosa.*
[5] *Mentha canadensis rubellus* Aven Nelson.
[6] *Cardous acaulescens.* A photograph is reproduced in the accompanying plate.

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The hardihood of the plants which grow in dry soil exposed to hot sun is something to interest the casual visitor as well as the botanist. The structural characters developed to adapt the plants to the different conditions of climate and soil in these mountains are well worth studying. Everywhere in the Colorado mountains a useful study can be made of plant distribution as affected by soil, moisture, and exposure to sun. Nowhere has the writer seen better opportunity for such study than in the region of Florissant.

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Wild geraniums growing on a hillside

General view of the lake basin

The Colombo (tall spike-like plants) on a hillside

Low "stemless" thistles (*Carduus acaulescens*)

Bee plant in foreground, shrubby pepper-grass farther back

VIEWS OF THE FLORISSANT LAKE BASIN, COLORADO

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VOLUME III NUMBER 4

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

AUGUST, 1906

Price, 50 Cents

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PRINTED AT
THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

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SOCIAL AND INDUSTRIAL EFFECTS OF RAILROAD RATE-MAKING[1]

By John Burton Phillips

Any intelligent study of the railroad-rate question involves a consideration of the social and industrial effects of freight rates. The rates at which freight is carried to and from various places in the United States are great factors in determining their prosperity. Unless this effect of freight rates is understood, no intelligent discussion of the proposal to take the rate-making power out of the hands of the railroads will be possible. In this paper some attention will be given to the effects of the freight rate on Atlantic ports, building parallel railroads, concentrating population in cities, and distributing industries.

At the present time the railroads are maintaining what is called a differential in the rates that prevail for the shipment of freight from the West to the ports on the Atlantic seaboard. It seems that the most accessible outlet for the grain that is grown in the Northwest was for many years the port of New York City. The New York Central and Hudson River Railroad secured the larger amount of freight if the grain was carried to the seaboard by the most inexpensive route. Other men had invested their capital in railroads, and these men wished that their capital so invested should yield a good profit. It was found that the Baltimore and Ohio, Chesapeake and Ohio, and the Pennsylvania could not compete at the usual freight rate for grain with the New York Central, and were being worsted in the competition that was then on. They therefore decided to engage in a rate war for the purpose of compelling the New York Central to come to terms with them and maintain a rate that would give to them a larger share of the grain destined for the seaboard. The war was begun and waged with remarkable fierceness, until finally in 1877 an agreement was reached by which the New York Central pledged itself to raise the rate on grain destined for export through the port of New York, so that that city would not be a serious competitor with the cities

[1] *Vide The Iron Trail*, March, 1905.

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on the Atlantic seaboard farther south. The rate was made about two cents higher for New York than for Philadelphia, and three cents higher than for Baltimore and Newport News.

The result of this agreement whereby the natural routes of transportation were changed to help railroads that could not compete with the New York Central, was soon seen in its effect on the growth of the city of New York. That city began to lose in relative importance as a port of international trade. Its exports and imports, which had been increasing at an enormous rate, while continuing to increase, yet showed a great diminution in their rate as compared with that of other ports favored by the differential. The merchants of New York besought the New York Central to remove the differential. The New York Central agreed to do so if the other roads would permit it. The roads interested were consulted, and they announced that in case the differential was removed a rate war would immediately be instituted. The differential was not removed. The merchants of New York, unable to obtain satisfaction from the railroads, thought of the Erie Canal. They appealed to the legislature, and the result was the adoption of a constitutional amendment providing for the expenditure of $101,000,000 for the purpose of deepening, widening, and straigthening the Erie Canal so that a 1,000 ton barge can navigate it. The canal is owned by the state, and no tolls are charged for its navigation. In this way it is expected that the problem of the differential will be in part eliminated. The sum of $101,000,000 is therefore a part of what it will cost the people of New York to allow the railway managers to maintain such a freight rate as will enable export grain to be carried to other cities than to that port which is its most accessible outlet.

The Erie Canal is the most expensive waterway in the world, and would long ago have been abandoned if it had not been that it is useful as a restraint upon the railway managers in the matter of adjusting rates. It has cost the state about three quarters of a million dollars a year for many years, and this needless expense will have to be paid till the business of making rates for railroads is put on a different basis. Aside from this annual expense for the maintenance of the canal, and the $101,000,000 appropriation of 1903, and the $9,000,000 of 1896, there is the annual loss to the entire country in the excessive freight rate that is maintained for

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the purpose of making inferior places equal to the principal export city. How much this is cannot be estimated with any degree of accuracy. It is certainly enormous.

It is true that the constitution guarantees that the government of the United States shall not do anything that will give one port an advantage over another. The purpose of this clause in our constitution is to provide that property shall be protected in those places which nature has fitted to be the chief seaports of the country. It was the aim of the constitution-makers that there should be no discriminating duties levied against any port and in favor of any other port. The constitution strives in this way to assure the equality of competition upon which theory our government rests. In thus attempting to guarantee that there shall be no discrimination against one port as compared with another, it was hoped that only the forces of nature which are over and above human control were to be allowed to have free play, and those ports that were most favored by nature would become the greatest places of export.

The fathers sought therefore to keep from the new government they were making the power to interfere with the natural growth of the various ports. It is unreasonable to assume that they thought Congress should not have the power to prevent individuals from destroying this very clause which they in their wisdom thought fit to insert in the fundamental law of the new government. Nor is it to be thought that in making this clause they believed that the natural advantages which any one port might possess should be destroyed by a company of individuals. When the differential rate on freight from the West to the seaboard is maintained in such a way as to prevent the trade going to the principal port of entry, it is an interference with the conditions established by nature and favoring the growth of seaports. Such a differential can make new seaport cities. In 1890 the population of Newport News, the terminal of the Chesapeake and Ohio, was 4,449; in 1900 it was 19,635—an increase of over 450 per cent.

The least expensive way for the United States to get its grain to the ships was formerly to take it to the harbor of New York. But the differential has changed this. By raising the price paid for hauling, it is now as easy to take the grain to various other seaports. That is, the people of

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the United States have been obliged to pay more for the sake of having their grain hauled to other and less advantageous seaports than New York. In other words, the entire people have been taxed for the purpose of benefiting the men who have put their capital into railroads which could not compete with those on the main route to the seaboard without some kind of an arrangement that would keep the price of hauling higher than would otherwise be the case.

The power of the government to fix rates is sufficient to stop the building of one railroad parallel to another. It is well known that there have been several instances in the United States where one railroad has been built parallel to another, not for the purpose of carrying freight and passengers, but solely for the sake of compelling the established road to buy it out or to divide the profits with it. When a railroad has become a great dividend-earner and its stock is at a high price, it will occur to certain unscrupulous persons that by building another road alongside of it they can compel it to buy the new road or divide the profits with them. It is a species of blackmail. The most conspicuous example of this is the West Shore railroad that was built from New York City to Buffalo. It parallels the New York Central nearly all the way. This road was built for the purpose of selling out to the Central, and after a rate war this wished-for consummation was brought about. The Nickel Plate is another example of the same thing. In these cases it is necessary for the older road to buy out the new one or its business is ruined. There is no one to control the freight rates that the bandit railroad can make, and as it is in the business for the purpose of selling out, it will make these rates so low that it will get all the trade away from the older road unless that road meets its rates, and it will continue this practice till the old road is obliged to buy the bandit road to save itself from destruction. Then, when the war is over and the bandit road has passed into the hands of the older road, the public is made to pay for the costs of war and the building of the robber railroad in the increased rates that must be made in order to recoup the older road for the deficit caused by the attack of the railroad banditti. It has even been suggested that this is one of the reasons why the government should not attempt to fix rates, because the railroads would not then have the opportunity of recouping themselves by increas-

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ing their rates after such an attack as has been described above. This appears to be a short-sighted argument. If the government could control the making of rates it could prevent a rate war. Government regulation of railway rates means that the low rate which a railroad desires to put in force would have to be approved by the Interstate Commerce Commission. How, then, could a railroad built parallel to another with the idea of waging a rate war till it was bought out at a fancy price, injure established dividend-paying property? If the government prevented the fixing of a low rate, the railroad banditti would be robbed of one of their most effective weapons. Forbidden to fix their rates at ruinous figures so as to get their business away from the old road, they would not desire to build a competing line for the purpose of selling out. Therefore, the capital which now goes into such worse than useless enterprises would find employment in legitimate fields.

The United States Industrial Commission recommended in its report in 1902 that the Interstate Commerce Commission be given the power to prevent the paralleling of railroads. It seems clear from the above observations that the power to make rates is all that is needed in order to stop paralleling. This prevention of parallel railroad-building will act as a guarantee to the railroads that they will not be molested by unscrupulous speculators. Therefore, government rate-making, whatever its dangers in other respects, will be very likely to protect the railroads from the depredations of certain marauders to which they are now exposed.

The effect of freight rates upon the concentration of our population in cities has never been fully pointed out. It is well known that one of our most serious problems is to induce people to remain in the smaller towns or in the rural districts. There are many causes operating to congest population in cities. Among these is the rate fixed by the railroads for carrying commodities.

A study of the growth of cities in the United States shows that those cities have grown most where there are several railroads. At these points the railroads have found it necessary to fix rates to compete with other roads and in some cases with steamships. Places thus favored by competitive rates are the places where manufacturers and jobbers are most likely to locate. When a town has but one railroad, and that

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has a monoply of its traffic, there is no overwhelming reason, from the manager's point of view, why the road should give this place as favorable a freight rate as it is obliged to give other places on its lines located at points with more than one railroad. The population of the small town therefore remains stationary, or even declines, owing to the fact that manufacturers, having located there in an early day, and having discovered the disadvantages they are under in the matter of transportation, decide to move their plants to the larger town where competitive rates prevail. Other lines of business are also crippled. Real estate in the town is affected, and its value declines. Farm land in the vicinity of the small town suffers and its value also declines. All things considered, a town from which goods must be transported at a higher rate than from other places on the same railroad is a good place to emigrate from. The same causes that make this a good town to leave make the place where lower rates prevail a good place to settle, and this is one of the reasons why the larger places are growing so rapidly. Railroad freight rates, as at present fixed, are tending to give a forced growth to our cities.

Freight rates are so adjusted that the distribution of industries is prevented. Why should the western part of the United States be supplied with great numbers of articles made in New York, when the same articles can be made in St. Louis? Why this enormous haulage? Manufactures have developed slowly in the western states, and these states are offering various inducements to encourage manufacturing industry within their borders. Many of these states are offering bounties, and others are exempting new manufacturers from taxation. One of the reasons for this lack of manufacturing development in the West is the freight rate from eastern cities. The rates are made low enough to enable the eastern manufacturer to invade successfully the local western market and deliver the goods there at a lower price than the local producer. This has tended to prevent capital from coming into the western territory to establish manufacturing industries. A conspicuous illustration of the attitude of the railways toward the movement of manufactures to the western states appears in the testimony of Professor Ripley before the United States Industrial Commission. A number of men had planned

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to build a pulp- and paper-mill in Denver and use the raw materials of that section to manufacture paper for the newspapers that circulate in that region. In this way the great expense of shipping this commodity a thousand miles might be avoided. Plans were under way when the attention of one of the railroads was called to the matter, and the officials of the road informed the promoters that if a paper-mill was built in Denver, and thereby the shipment of paper from Wisconsin interfered with, the railroads would kill the enterprise at any cost to themselves. This they could do by lowering the freight rate on paper from the East. The promoters were greatly discouraged, but, as the freight rate was so high, they decided to build the mill. Plenty of timber was available in the near-by mountains. Coal mines were in active operation within twenty miles of Denver. There was every reason why the mill should succeed and the great expense of hauling paper 1,000 miles from Wisconsin be saved. The rate on incoming paper had been $1.55 a hundred, and the complaints about the high rate had been one of the leading causes that had led to the erection of the mill. As soon as the mill went into operation, the railroads reduced the rate on incoming paper to $0.25 a hundred. It is not surprising that the mill went into bankruptcy.[1]

The following table of rates from eastern points to Denver, and also from eastern points to the Pacific coast, shows very clearly how the development of a city as a manufacturing and jobbing center may be checked by the adjustment of freight rates. This table is compiled from testimony given by witnesses before the Industrial Commission in 1901, and represents the rates in force at that time. Though there have been changes since, the figures are still valuable as showing the influence of freight rates on the industrial growth of Denver. The most striking feature of this table is the great discrimination against Denver and in favor of San Francisco. It is hard to understand why the freight rate for hauling boots and shoes from Chicago to San Francisco should be less than the charge for hauling them to Denver, 1,200 miles nearer. Why the rate from Denver to San Francisco should be more than the rate from Chicago to San Francisco is still more incomprehensible! This is an open violation of the long-and-short-haul clause

[1] *Report of the Industrial Commission*, Vol. IV, p. 264; *ibid.* Vol. IX, p. 287.

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FREIGHT RATE DISCRIMINATION AGAINST DENVER

Commodity	Whence shipped	Rate to Denver	Rate to San Francisco
Boots and shoes	Chicago	$2.05	$1.50
Boots and shoes	Denver	....	3.00
Books	Chicago	2.05	1.75
Books	Denver	....	3.00
Oil	Chicago	....	0.78½
Oil	Denver	....	0.80
Crockery	Trenton	1.53	0.95
Oil cloth, Linoleum	Missouri River	0.80	0.75

of the interstate commerce law. In the evidence before the commission mention is made of a man who desired to start a publishing house in Denver and print books to sell on the Pacific slope. As soon as he found the freight rate on books to be $1.75 from Chicago to San Francisco and $3 from Denver to San Francisco, he decided to manufacture books in Chicago. The table shows that the same considerations would prevail with other manufacturers and jobbers. A jobber in boots and shoes could not live in Denver if he had to pay $2.05 freight from Chicago to Denver and $3 from Denver to San Francisco, a total of $5.05 in freight from Chicago, when the jobber in Chicago could lay down the same goods in San Francisco for $1.50. This explains what was pointed out by witnesses before the commission, namely, that various jobbers had withdrawn from Denver to Missouri River points and Chicago. It was stated to the commission that, owing to the difference in rates on oil, that commodity had been shipped from the East to San Francisco and back to Denver at a profit to the Denver dealer.[1]

The population of Denver increased from 106,713 in 1890 to 133,879 in 1900—an increase of 25.4 per cent. At first thought this would seem to be an indication of great industrial prosperity. Such, however, is not the case. It must not be forgotten that among the various attractions of the city of Denver, one of the most conspicuous is the favorable effect of its climate upon those persons afflicted with tubercular disease, and a large part of this increase in population is represented by persons that have sought Denver as a place of residence while in quest of health.

[1] *Report of the United States Industrial Commission*, Vol. IV, p. 68.

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The best index of the industrial growth of Denver during the above period is the census of manufactures. While the census figures for 1900 show an increase of 41 per cent. in the value of Denver manufactures over the manufactures of 1890, these figures are entirely illusory. The increase is only apparent, as the figures for 1900 include the products of smelting and refining ores, and these products were not included in the census figures for manufactures in 1890. In that census these industries are classed as mining. Excluding the products of these industries, the value of Denver manufactures in 1900, as compared with their value in 1890, shows a decline of 5.6 per cent.[1]

The growth of the city, therefore, was not due to the increase in general manufactures. With the development of mining, however, there has been a great development along certain lines of manufacture, such as that of mining machinery. The growth of the smelting and refining industry has also had much to do with the present prosperity of the city. While Denver is now a flourishing city, it is greatly to be regretted that its development as a manufacturing and distributing center for the Rocky Mountain region has been so greatly interfered with by discriminating freight rates.

In this way the railroads prevent the distribution of industries in this country. They are in the hauling business, and therefore opposed to the self-sufficiency of the different sections of the United States. The logical result of such a policy is to keep the East a manufacturing section with great industrial cities, crowded tenement-house populations, sweat-shop industries, contagious diseases, and high mortality, while the West is obliged to engage largely in industries which produce raw material.

Such are some of the social and industrial possibilities of the rate-making power. Whether or not the American people will decide to take this power from the railroads and vest it in a public supervisory tribunal, or whether they will prefer to hope for the development of an enlightened public spirit on the part of the railroad managers, is a question whose answer will be awaited with much interest by all thoughtful persons.

[1] *Twelfth Census, Manufactures*, Part II, p. 65.

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THE COUNTY BOUNDARIES OF COLORADO

By Frederic L. Paxson

The early history of the state of Colorado is of necessity closely connected with that of the territories from which lands were taken to endow the new commonwealth. Kansas, Nebraska, Utah, and New Mexico were all levied upon, and out of the lands thus provided was erected, under the stimulus of the discovery of gold near Pike's Peak in 1858, the new territory bearing the name of Colorado, by the act of February 28, 1861.[1]

The territorial history of the Colorado lands in connection with Nebraska, Utah, and New Mexico has not yet been made accessible. Kansas three times passed laws which are of interest in the history of the new terrritory.[2] In the year 1855 she created the county of Arapahoe, embracing all of her territory west of the one hundred and third meridian, while the county of Washington, south of thirty-eight degrees and thirty minutes, included the southeast corner of Colorado. Neither of these counties was ever organized, Arapahoe being attached to Marshall, as was Washington to Allen, for purposes of government, and both of them being reshaped before their local settlement justified any formal organization. The discovery of gold in Arapahoe county in 1858 brought about the repeal of the act of 1855, and the substitution for the two counties of Arapahoe and Washington, within Colorado limits, of the counties of Oro, Broderick, Montana, Arapahoe, El Paso, and Fremont, all lying west of the one hundred and third meridian. The southern end of the single degree east of this meridian, losing even its nominal Washington county in 1859, became in the following year a part of the county of Peketon. And in this condition all of Kansas west of the twenty-fifth meridian from Washington (approximately the one hundred and second from Greenwich) was cast adrift when Kansas was admitted into the union on January 29, 1861.

[1] F. L. Paxson, "The Boundaries of Colorado," in *University of Colorado Studies*, Vol. II, pp. 87–94.

[2] H. G. Gill, "The Establishment of Counties in Kansas," in *Kansas Historical Society Collections* Vol. VIII, pp. 1–23, with sixteen outline maps.

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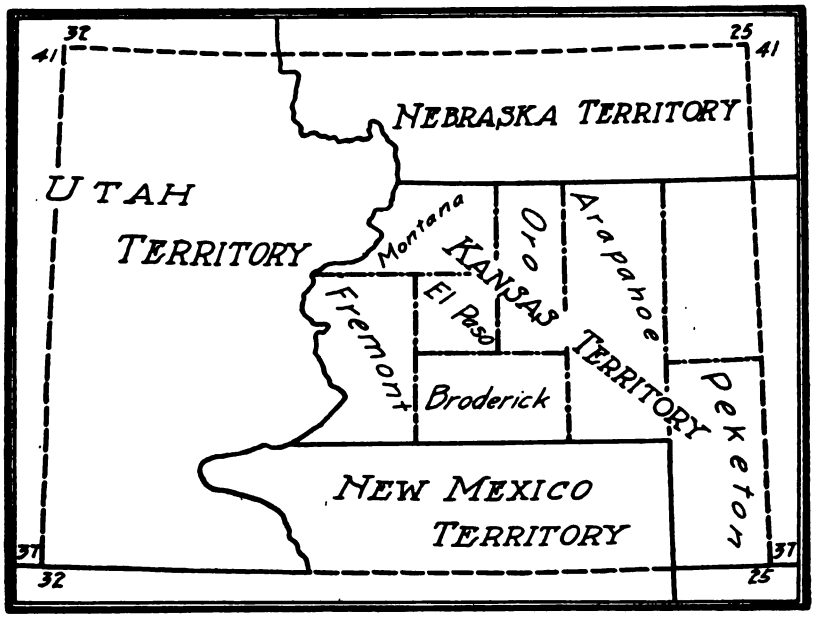
The first legislative assembly of the territory of Colorado met in Denver in the autumn of 1861 to pass, among others, a law dividing the whole territory into seventeen counties.[1] Of these original counties, six embraced large areas of plains lands of the eastern slope—Weld, Arapahoe, Douglas, El Paso, Pueblo, and Huerfano. Three covered the whole



MAP I.—1861—Before Admission of Kansas.

unoccupied western slope—Summit, Lake, and Conejos.[2] Two, Fremont and Costilla, divided the eastern and western slopes at the south while six mountain counties in the center of the state—Larimer, Boulder, Gilpin, Clear Creek, Jefferson, and Park—have until this day remained in their original limits as witnesses to the wisdom of the legislature which brought them into existence.[3]

In defining the boundaries for these first counties the legislature made large use of the lines of the United States survey, which had begun in the

[1] Act of November 1, 1861 (First Legislative Assembly, *Session Laws*, pp. 52–57).

[2] The act of November 1, 1861, created a county of Guadaloupe, whose name was changed by the act of November 7, 1861, to Conejos (*Sess. Laws*, 1861, p. 143).

[3] These central counties contained most of the population of the territory, for here were the great mining camps.

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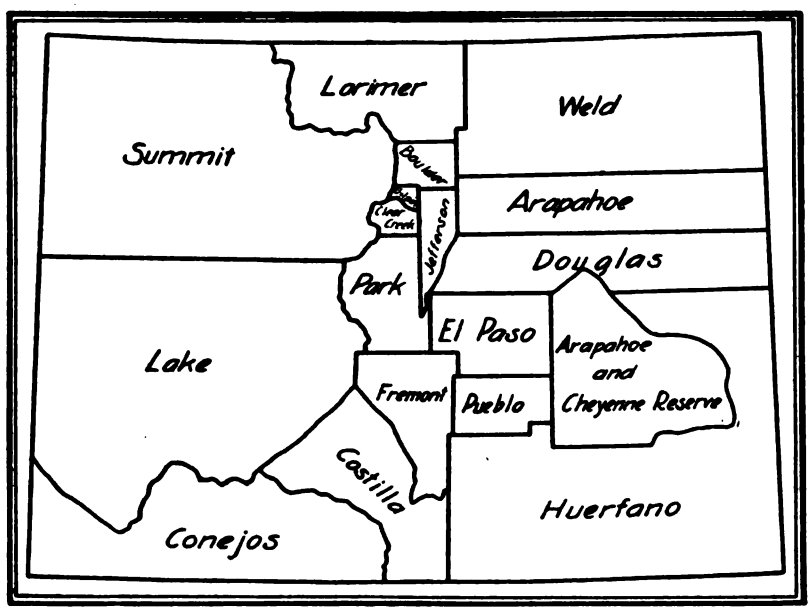
territory a few months before the act was passed. The eighth guide meridian, passing through the town of Pueblo, gives the location to ranges in the whole state, save the southwest corner. And the base line of the fortieth parallel is used over the same area. In the southwest, and in later years, the New Mexico principal meridian replaces the eighth guide of the eastern slope. The six eastern counties were all defined with reference to these base and range lines, in existence or projected.



MAP II.—1861—First Legislative Assembly.

The central counties made much use of the Snowy Range, which the courts later determined to mean the continental divide when not further qualified by a local name, as Mosquito or Sangre de Christo or La Plata range.[1] The western counties, beyond the region of accurate survey or actual settlement, were open to confusion in the case of the Lake-

[1] This ruling was made in a suit in which Grand county endeavored to establish the Medicine Bow range as its eastern boundary, which was by definition the "Snowy Range" (Grand County *v.* Larimer Co. *Colorado Supreme Court Reports*, Vol. IX, p. 268, April term, 1886). In the following year the legislature provided that disputed county boundaries should be determined and surveyed by the state engineer (Act of April 4, 1887, *Sess. Laws*, 1887, p. 288).

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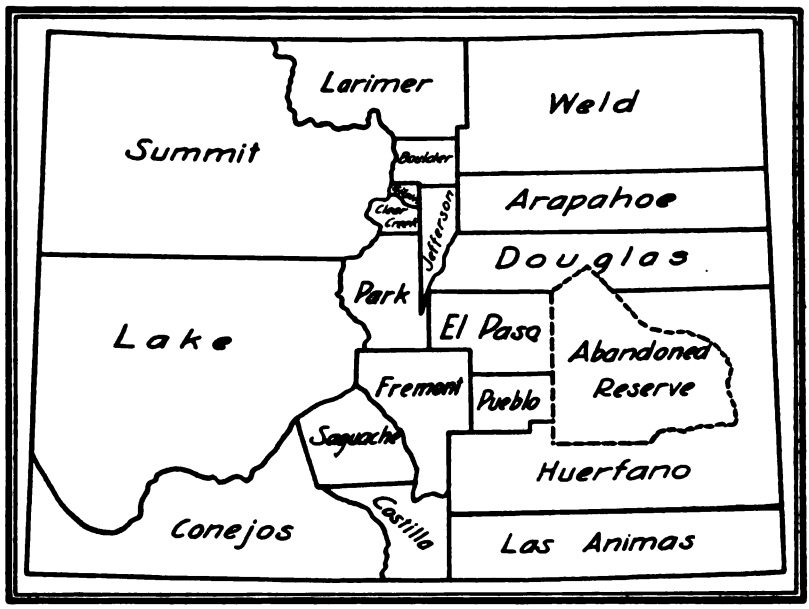
Conejos line which was defined as running along a range, the La Plata, which was misplaced in the maps used by the legislature; but this mistake was corrected before the opening of the San Juan country made it a matter of importance.[1] It is worthy of note that four of the eastern



MAP III.—1866—Second to Sixth Assemblies.

counties were bounded in part by the Cheyenne and Arapahoe reservation, established by treaty of February 18, 1861, and lasting until after the treaty of Little Arkansas, of October 14, 1865, which followed the serious plains war of 1864.[2] In no other instance did Colorado allow a reservation to interfere with the extension of county boundaries over its area. The Ute reservations in the west were always covered by these lines.

From 1864 until the arrival of the railways in 1870 Colorado failed to continue in the rapid growth which had been hoped for in the early sixties.

[1] There is a range indicated as "La Plata" in the position evidently contemplated in 1861, in "Map No. 4: From the Coo-che-to-pa Pass to the Wahsatch Mountains," in *Reports of Explorations . . . . for a Railroad from the Mississippi River to the Pacific Ocean* (Washington, 1861), Vol. XI. This range separates the rivers San Juan and Dolores, along which divide the line is drawn in the maps accompanying this article.

[2] C. C. ROYCE, "Indian Land Cessions in the United States," in *Bureau of American Ethnology*, Eighteenth Report, 1896–97, Part 2, pp. 824, 838, and maps.

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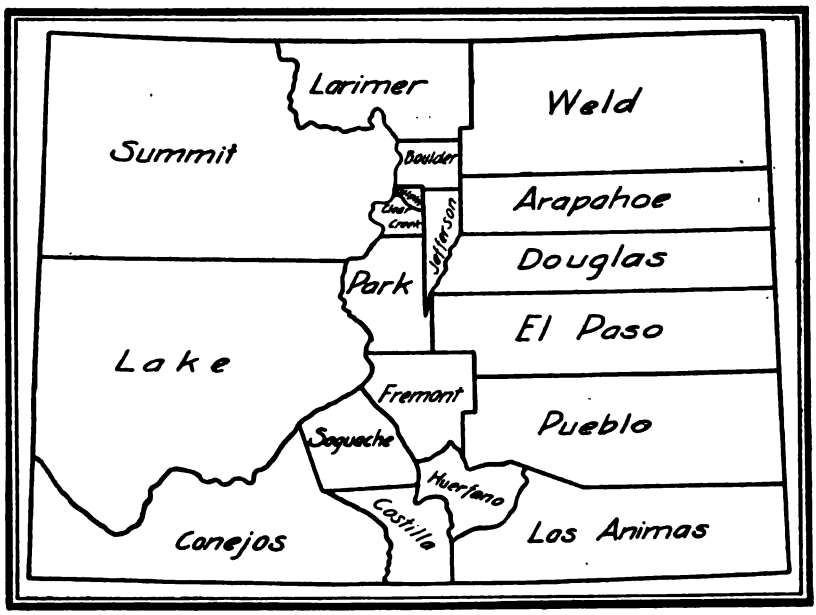
Her mines were in a measure discredited, statehood failed in spite of the exigencies of the Republican party in Congress, and population seems actually to have fallen away during these years. The county process indicates this stagnation in its own leisurely development.



MAP IV.—1868—Seventh Assembly.

With the exception of Saguache, formed out of that part of Costilla north of La Loma del Norte and Moscow Creek,[1] no new county was created on the western slope during these years. Saguache was the work of the sixth legislative assembly sitting at Golden in 1866-67. Its northwest boundary was not the original Costilla-Lake line of 1861, but a new line erected for Costilla-Conejos by the third legislature in 1864, and extending from the top of Cochetopa Pass to "the mouth of the canon of the Snowy Range from whence flows the Rio Grande del Norte,"[2] the southern point being later determined by the state engineer as the town of Del Norte, situated in La Loma del Norte.[3]

[1] *Sess. Laws*, 1866–67, p. 54, act of December 29, 1866.

[2] *Sess. Laws*, 1864, p. 68.; February 24, 1864.

[3] Cochetopa Pass was in 1892 defined by the state engineer as situated in S. W. Cor., Twp. 46 N., Range No. 4, East, of New Mexico Principal Meridian (*Colorado State Engineer, Sixth Biennial Report*, p. 49). The 'mouth" of the canon was located in this same report (p. 44).

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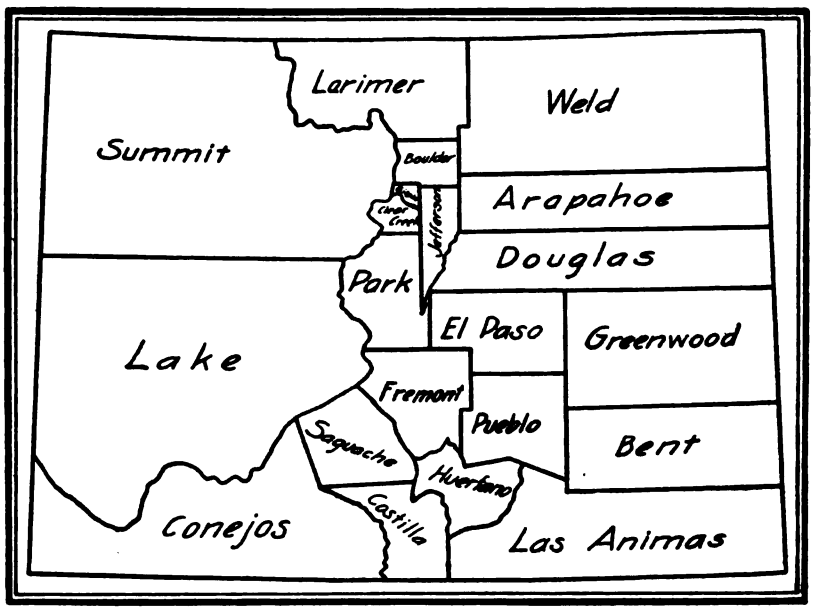
On the eastern slope the corners of Fremont county were straightened out by the fifth and seventh assemblies of 1866 and 1868,[1] while the county of Las Animas made its appearance in the former year, formed from that part of Huerfano county south of thirty-seven degrees and thirty minutes.[2]



MAP V.—1870—Eighth Assembly.

The disappearance of the Cheyenne and Arapahoe reservation, and the removal of the Indians, forced a revision of these southeastern lines in 1868, with the result that the seventh legislature restricted Huerfano county to its modern irregular bounds and divided its old territory between Pueblo and Las Animas, its neighbors on the northeast and southeast.[3]

[1] An act of March 11, 1864 (*Sess. Laws*, 1864, p. 69), had given a conditional modification to Fremont, depending upon a certain Beaver Creek. This act was repealed by the act of February 6, 1866 (*Sess. Laws*, 1866, p. 47). The later act of January 6, 1868 (*Revised Statutes*, 1868, p. 163), substituted the range of mountains east of the Arkansas River for the original northwestern line, the new line crossing the Arkansas three miles below the mouth of the South Arkansas in order to connect with the range mentioned.

[2] February 9, 1866 (*Sess. Laws*, 1866, p. 49).

[3] Act of January 9, 1868 (*Revised Statutes*, 1868, p. 164). These *Revised Statutes* were authorized by the seventh assembly and form the first revision of Colorado laws.

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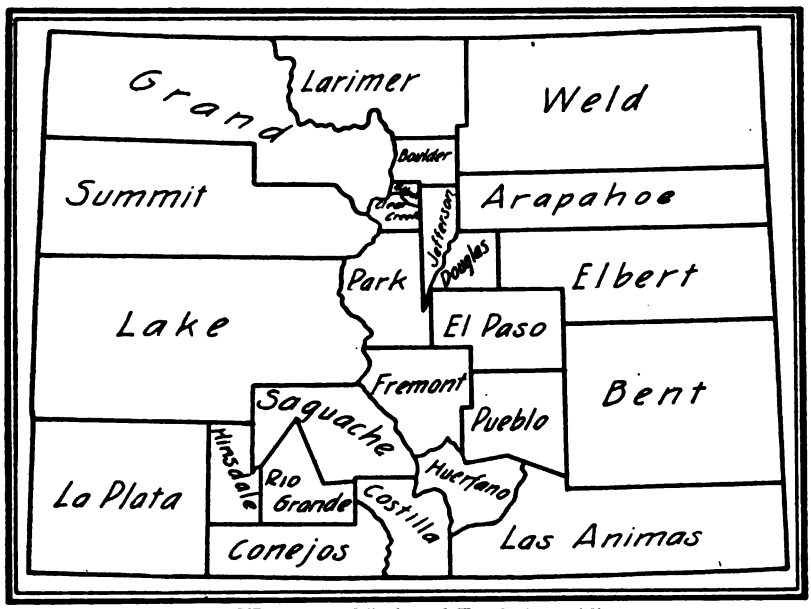
The advent of the railway in Colorado left its necessary imprint upon county organization. The Denver Pacific, connecting Denver and Cheyenne, and the Kansas Pacific, otherwise known as the Eastern Division of the Union Pacific, reaching the territorial capital from the east, both came into operation in the summer of 1870. Greenwood and Bent counties



MAP VI.—1874—Ninth and Tenth Assemblies.

had preceded the Kansas Pacific by some months,[1] while the activity around the county seat of the former, Kit Carson, caused by the heavy Santa Fé trade springing from the railway at that point,[2] gave a considerable activity to speculation in territorial lands. The county of Elbert, south of Arapahoe, came with the tenth legislature in 1874 at the expense of Douglas and Greenwood,[3] while the latter gave to Bent what Elbert did not need and itself disappeared from the map.[4] In this condition,

[1] Act of February 11, 1870 (*Sess. Laws*, 1870, p. 53).

[2] The Arkansas Valley Railroad was constructed by Kansas Pacific interests to connect Kit Carson and Pueblo. It was built as far as La Junta, further extension being unnecessary since the Santa Fé had already reached Pueblo by La Junta. The Arkansas Valley was never a success, closed down in 1877, was sold under foreclosure in 1878, and is today abandoned. (POOR, *Railway Manual*, 1878, p. 894.)

[3] Act of February 2, 1874 (*Sess. Laws*, 1874, p. 69).

[4] Act of February 6, 1874 (*Sess. Laws*, 1874, p. 61). The *Ninth Census*, 1870, had given to Greenwood a population of 510 (Vol. I, *Population*, p. 16).

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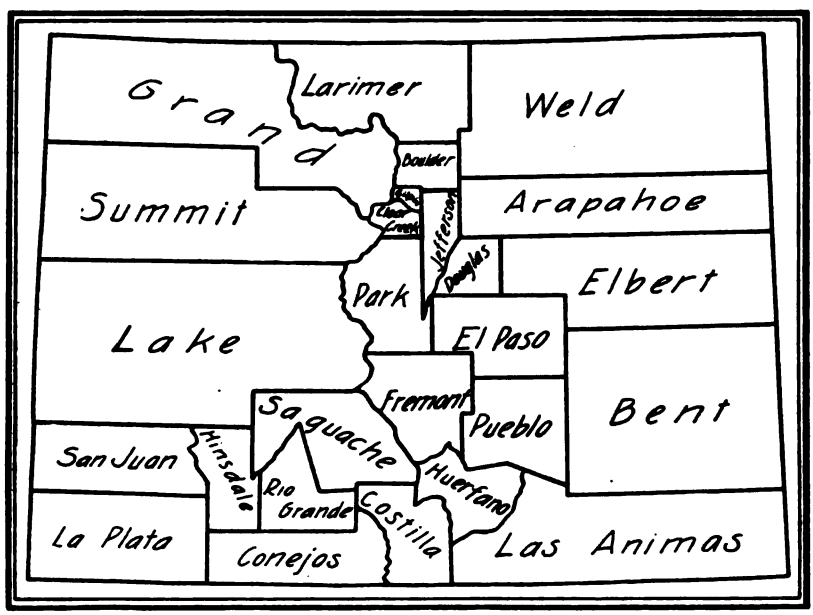
save for the county of Custer, made in 1877,[1] the eastern slope remained through the rest of the seventies and through the eighties to 1887.

On the western slope of Colorado the seventies show a greater county activity than on the eastern. The early counties beyond the range had lost much of their importance from the fact that the Ute reservation covered most of the useful lands. But the Indians receded before the prospecter during this decade,[2] allowing the creation of many new counties in place of the original three—Summit, Lake, and Conejos.



MAP VII—1876—Eleventh Territorial Assembly.

Saguache county was the first to change in the early seventies, receiving in 1872 a new northern line in the latitude of Poncha Pass, and a new

[1] Act of March 9, 1877 (*General Laws*, 1877, p. 211). The first general assembly of the new state of Colorado published no *Session Laws*, but embodied the statutes of 1877 in a code of *General Laws*.

[2] The original reserve, west of 107° and south of fifteen miles north of 40°, was based on a treaty March 2, 1868. The Utes ceded the San Juan rectangle out of this by a treaty of September, 13, 1873, and the remaining portion, save for the fifteen mile strip of the Southern Ute reserve, by an agreement of March 6, 1880. (ROYCE, *Indian Land Cessions*, pp. 848, 864, 874, 899, 904, 908; *House Executive Document* 66, *Forty-fifth Congress, Second Session*.)

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western line along the Ute reserve in one hundred and seven degrees.[1] The next legislature, the tenth in 1874, was able to take advantage of the cession by the Utes of their San Juan lands, and to create three southwestern counties at the expense of Conejos and Lake. The large county of La Plata received on the east a meridian six miles west of the mouth of Lost Trail Creek on the Rio Grande, and on the north a parallel ten miles north of the thirty-eighth parallel,[2] both of which boundaries were shortly to give way to more reasonable lines along the obvious summits. Conejos was in the same year forced back of the ninth correction line and the first guide meridian east of the New Mexico principal meridian, while the lands thus surrendered were divided by the New Mexico meridian itself into Hinsdale and Rio Grande. The county of Grand was erected by the same tenth assembly out of that part of the huge Summit north of the Ute reserve and the line between townships Nos. 1 and 2 south.[3]

The eleventh legislature, 1876, the last of the territorial series, added San Juan to the southwestern group, taking from La Plata for the purpose its lands north of nine miles south of the tenth correction line, and erecting a mountain line for most of San Juan's eastern boundary.[4] The impossibility of the 1861 Conejos-Lake line was by this time clearly seen in that the La Plata range not only did not cross the western boundary of the territory, but did not even connect with the continental divide at the source of the Rio Grande, which the statute called upon it to do. With this legislature the territorial period ended, twenty-six of the counties of Colorado being in existence.[5]

[1] Act of February 9, 1872 (*Sess. Laws*, 1872, p. 81). The state engineer, under act of April 4, 1887, has determined the summit of Poncha Pass to be "Intersection Peak" as indicated on Sheet VII of F. V. HAYDEN, *Atlas of Colorado* (Washington, 1881). (*Colorado State Engineer, Fourth Biennial Report*, Part I, p. 116.) The court of appeals sustained his ruling in September, 1892 (Gunnison Co. *v.* Saguache Co. *Colorado Court of Appeals Reports*, Vol. II, p. 412).

[2] Act of February 10, 1874 (*Sess. Laws*, 1874, p. 66). A single act defined the boundaries of the three counties, and in a later section (No. 13) established the tenth correction line as a new boundary between Costilla and Saguache.

[3] Act of February 2, 1874, (*Sess. Laws* 1874, p. 71). The mountain boundary of the new Grand left the Snowy Range where it throws off a spur between the Williams' Fork and Blue Rivers, on the west boundary of Clear Creek, and follows the spur range to the township line mentioned.

[4] Act of January 31, 1876 (*Sess. Laws*, 1876, p. 58).

[5] The writer is indebted to one of his graduate students, Mr. Frederick Eugene Hagen, for assistance in the preliminary survey of the territorial period. He has, however, based all his conclusions upon a persona examination of the statutes involved.

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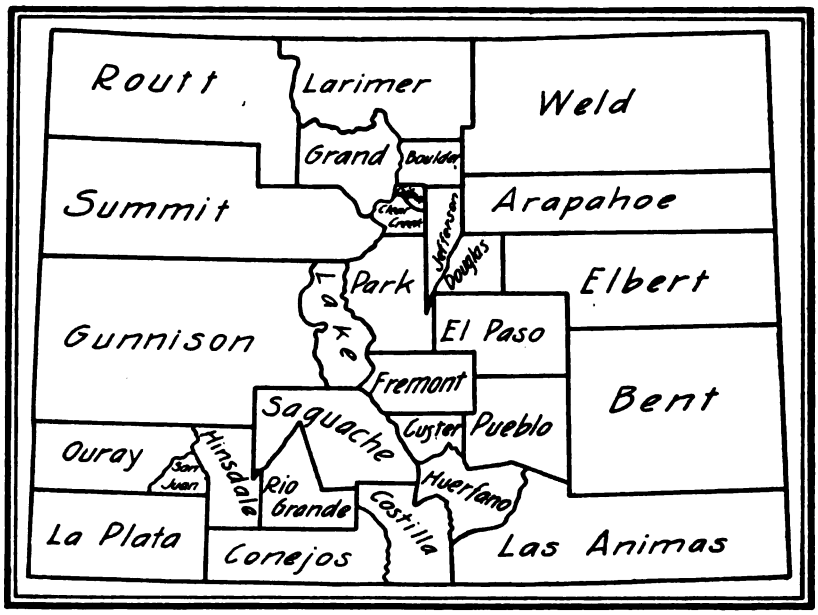
The first general assembly of the new state, meeting in 1877, took up the process of subdividing the west so vigorously that three new counties made their appearance in this year. San Juan, which had come into existence only the year before, was cut down until it reached its present location and boundary, while so much of the original territory as lay west



MAP VIII.—1877—First General Assembly.

of an irregular mountain line became the new county of Ouray.[1] Lake county was confined to the east of the continental divide or Snowy Range, while its discarded portion received the name of Gunnison.[2] Routt county was cut off from Grand with an eastern boundary that was at a later day to cause litigation with both its mother-county and Larimer.[3]

[1] Act of January 18, 1877 (*General Laws*, 1877, p. 207).

[2] Act of March 9, 1877 (*General Laws*, 1877, p. 213).

[3] The western boundary of Larimer was determined by the supreme court in Grand Co. *v.* Larimer Co. (IX *Colorado*, p. 268). Routt county received a somewhat uncertain boundary in the act of January 29, 1877 (*General Laws*, 1877, p. 209). In one section it was to include that part of Grand lying west of a defined line, while the defined line, starting from the intersection of south line of Grand and the Gore Range, and running north to the Wyoming territorial line, ran, through half its length, through North Park and Larimer county. Thus a technical contention based upon the more definite boundary statement might have included in Routt a part of Larimer. The identity of Gore Range caused litigation between Routt and Grand over a twelve-mile strip. The state engineer, J. S. Green, identified the point of intersection at Yarmany Peak, his ruling

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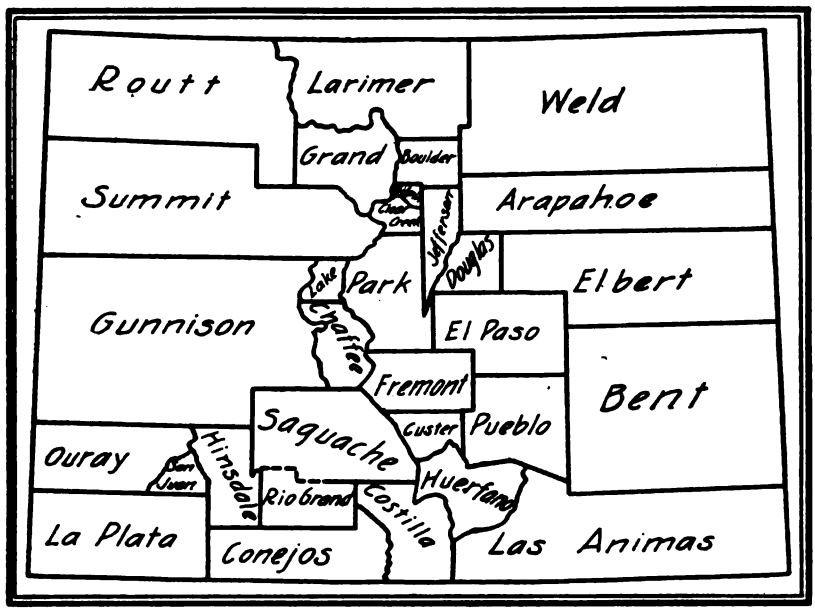
In 1879 the second state assembly gave to Saguache, already a much-bounded county, a new line on its south, and at the same time a ground for future litigation.[1] To the adjoining county of Lake, between Snowy



MAP IX.—1879—Second General Assembly.

being overthrown and the point being placed twelve miles farther west by the district court of Grand upon appeal of Grand. The court of Appeals, in 1894, reversed the decision of the court below, and remanded the case (IV *Colorado Court of Appeals*, p. 306). Subsequently the county attorneys of Grand and Routt agreed to run the line from the southwest corner of township No. 1, range 82, west.

[1] An adjudication of the common boundaries of Saguache, Hinsdale, and Rio Grande occurred after the beginning of the mining boom at Creede and before the creation of Mineral county in 1893. In order to determine the location of certain of the new camps, appeal was jointly made by the counties to the state engineer, J. B. Maxwell, under the act of 1887. Maxwell sat at Creede in March, 1892, and handed down a decision defining the southern boundary of Saguache as running from the intersection of the tenth correction line north with the first guide meridian east of the New Mexico principal meridian, west to an intersection with a line running northwesterly from Del Norte to Cochetopa Pass, and northwesterly to said pass; thence southwesterly along the continental divide to the one hundred and seventh meridian. (*Colorado State Engineer, Sixth Biennial Report*, pp. 42–50.) This decision of the state engineer was later contested by Mineral county, and the district court of Chaffee reversed the decision on the ground that the procedure of the state engineer was illegal, his duty being to survey a line, not merely to adjudicate it. The court also took evidence and established the Rio Grande River, west of the New Mexico meridian, as the southern line of Saguache, in place of the continental divide. Upon the appeal of Hinsdale, this decision was reversed by the court of appeals at its April term, 1897 (*Colorado Court of Appeals Reports*, Vol. IX, p. 368). A year later, the court of appeals was itself reversed by the supreme court, upon the appeal of Mineral (*Colorado Supreme Court Reports*, Vol. XXV, p. 95). In the light of these decisions, the Saguache-Hinsdale line must be inter-

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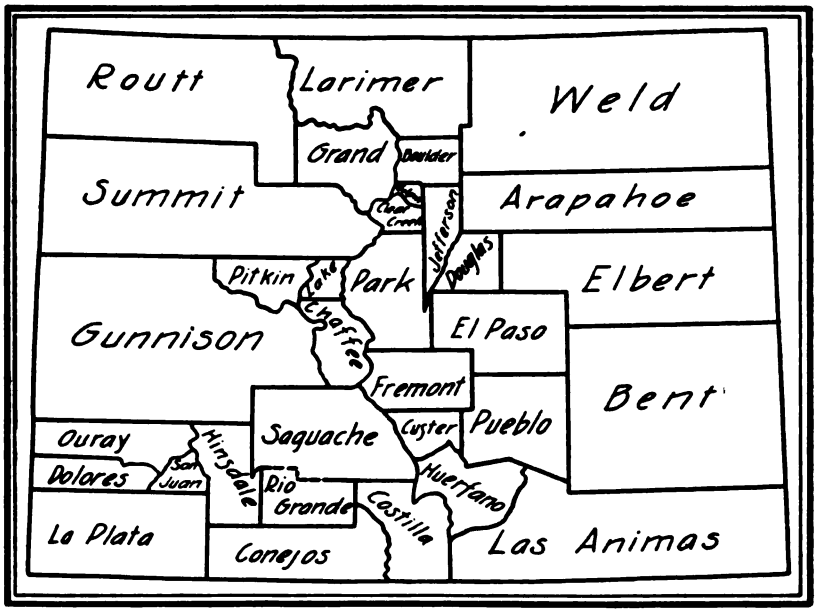

MAP X.—1881—Third General Assembly.

and Mosquito Ranges, its attention was called by the discovery of great silver lodes near the old town of Oro. At first it divided the county, giving its north end, north of five miles south of the first correction line, the descriptive name of Carbonate.[1] But before the session ended, Car-

preted as running in part along the Rio Grande, although the writer has been unable to find any statutory authority for the ruling of the Chaffee county court, and inclines to the opinion that a better interpretation of the statute would have been reached had the court been able to pass the matter back to the state engineer for lawful action, rather than to decide the location of the line itself.

The Saguache-Rio Grande line is likewise in some doubt. When Rio Grande was erected in 1874 its northern line was the old southern line of Saguache, passing through Del Norte and Cochetopa Pass. In an act of February 8, 1879, Rio Grande was increased by all of Saguache lying south of the tenth correction line, from its intersection with the first guide meridian east, west thirty miles, north six miles, and west to the Hinsdale line (*Sess. Laws*, 1879, p.48). It has been commonly held that this act transferred to Saguache all of Rio Grande lying north of the described line, and in this spirit the best maps are commonly drawn. But the text of the act contains no reference whatever to an increase of Saguache. The maps here presented accept the current assumption that such was the intent of the legislature of 1879, and that the statute was merely defective in phrase. But there is much reason to believe that a technical interpretation of the law would restore to Rio Grande its Cochetopa triangle. Such was the opinion of Maxwell in 1892, and the writer accepts his argument as conclusive. The Chaffee county court threw out his ruling because of the manner in which it had been made, not on any avowed ground of an incorrect interpretation of law (*Sixth Biennial Report*, p. 47).

[1] Act of February 8, 1879 (*Sess. Laws*, 1879, p. 47). The "Camp of the Carbonates," as Leadville was popularly known, brought Colorado into the public eye in 1878 and 1879. Some of the contemporary bibliography may be found in F. L. PAXSON, "Preliminary Bibliography of Colorado History," in *University of Colorado Studies*, Vol. III, pp. 19–24

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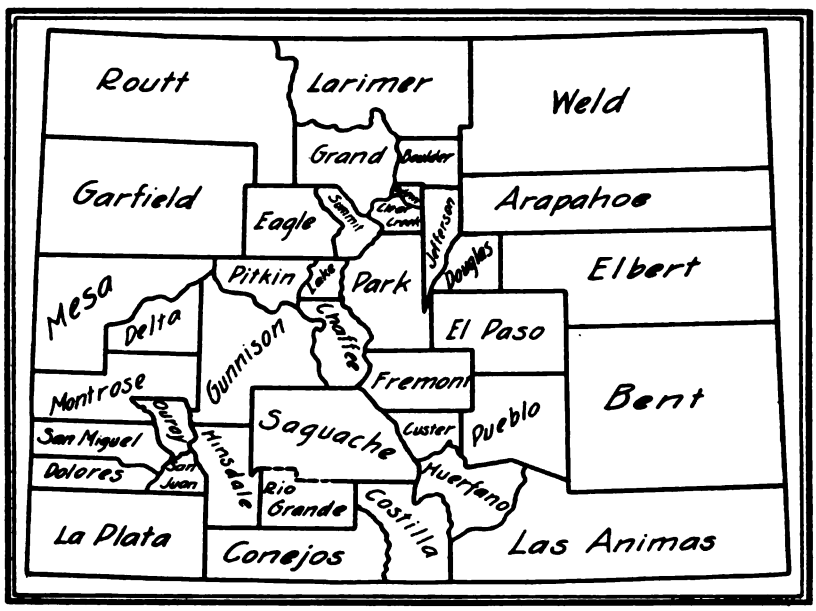
bonate had been discarded for the old name of Lake, while the southern end received the new name of Chaffee.[1]

Two years after the Leadville boom of 1879, the third assembly divided the county of Ouray, to erect that of Dolores, and cut off the northeastern corner of Gunnison to receive the name of Governor Pitkin.[2] But it was not until the time of the fourth assembly, in 1883, that the final



MAP XI.—1883—Fourth General Assembly.

removal of the last of the Uncompahgre Utes made it possible to reduce the counties of the west to reasonable dimensions. In this year, 1883, Summit was restricted to its present limits, while out of its western end were erected Eagle and Garfield.[3] Gunnison was likewise reduced to its

[1] Act of February 10, 1879 (*Sess. Laws*, 1879, p. 48).

[2] Dolores was erected by act of February 19, 1881, and Pitkin by act of February 23 (*Sess. Laws*, 1881, pp. 92, 89). The joint line of Garfield, Pitkin, and Mesa was run by the state engineer in 1890 (*Fifth Biennial Report*, Part I, p. 14.).

[3] Garfield, February 10; Eagle, February 11; (*Sess. Laws*, 1883, pp. 130, 127). The Eagle-Summit boundary was defined, in its northern end, as the divide between the Piney and Blue Rivers. A later and better geographical knowledge showed that two divides exist between these rivers, being themselves separated by the Sheephorn Creek and valley. The state engineer, John E. Field, surveyed the line in 1897 and accepted the eastern divide as the statutory line, throwing the Sheephorn valley into Eagle county (*Ninth Biennial Report*, p. 30). The line between Garfield and Eagle had been run by the same official in 1893 (*Seventh Biennial Report*, p. 221).

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present dimensions, Mesa, Delta, and Montrose being created wholly, and Uncompahgre in part, at its expense.[1] The meridian of one hundred and seven degrees, thirty minutes, became the western line of the reduced county, while the Delta-Mesa line followed the edge of the Grand Mesa in part. A new county of Uncompahgre was created by this assembly, comprising all of the valley of the Uncompahgre River and its tributaries south of thirty-eight degrees and twenty minutes, and north of the San Juan county line. Before the session ended the name of San Miguel had been applied to the old county of Ouray, while the name Ouray had been transferred to the new county of Uncompahgre.[2]

The history of the western slope since 1883 is quickly told. Archuleta came with the fifth assembly in 1885, to reduce Conejos to its present limits west of the continental divide.[3] In 1889 the seventh assembly divided La Plata along the mountain range of the same name, and gave the name Montezuma to its western end, in honor, perhaps, of its prehistoric ruins.[4] It ran also an irregular line along the lines of the United States survey in creating Rio Blanco in the northern part of Garfield.[5] The ninth assembly, four years later, separated Rio Grande and Hinsdale counties by the new county of Mineral, four ranges wide and running from the ninth correction line to the continental divide.[6]

During the eighties Colorado developed as an agricultural state more rapidly than before. Irrigation had ceased to be an experiment; while the assertion by the state of its rights to control its waters, together with the supervision of the state engineer over hydraulic conditions, founded

[1] Mesa, February 14; Delta, February 11; Montrose, February 11; Uncompahgre, February 27 (*Sess. Laws*, 1883, pp. 133, 124, 136, 139).

[2] Uncompahgre was created by act of February 27, 1883, and had its name changed to Ouray, March 2, 1883 (*Sess. Laws*, 1883, p. 130). The dividing line between the new Ouray and San Juan had been defined by act of January 18, 1877 (*General Laws*, 1877, p. 207). It depends upon the location of a certain Mineral Creek which empties into the Uncompahgre River, and is of great importance because it traverses a rich mineral district. The line is now (1906) in the hands of the state engineer, whose chief difficulty is to identify Mineral Creek. The northern line of 38° 20′, calling for an astronomical location, is also in the hands of the state engineer.

[3] Act of April 14, 1885 (*Sess. Laws*, 1885, p. 40).

[4] Act of April 16, 1889 (*Sess. Laws*, 1889, p. 262).

[5] Act of March 15, 1889 (*Sess. Laws*, 1889, p. 325). The act is carelessly worded in its definition of the survey lines, but its intent can be easily seen.

[6] Act of March 27, 1893 (*Sess. Laws*, 1893, p. 94). This act was carelessly phrased. A later act of April 24, 1895, was necessary to bring its wording into harmony with its intent (*Sess. Laws*, 1895, p. 205).

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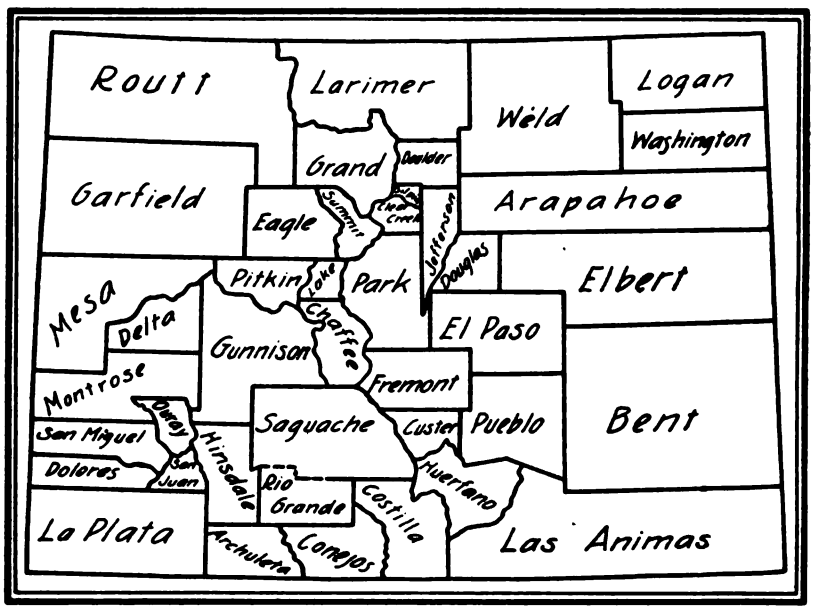
irrigation rights upon bases more equitable than had been known before.[1] The resulting expansion in the Platte and Arkansas valleys started anew the county growth on the east slope that had paused after the erection of Custer in 1877.



MAP XII.—1887—Fifth and Sixth Assemblies.

The county of Weld, one of the original seventeen of 1861, had complete control of the waters of the lower Platte until 1887. An attempt to create a county of Platte out of its eastern end had been made in 1872, but had failed to secure the required approval at the polls.[2] And thus Weld remained unbroken until the sixth assembly of 1887

[1] The act of February 19, 1879, inaugurated the policy of control of irrigable streams by the state, by erecting ten irrigation districts with a water commissioner for each. Two years later, March 5, 1881, the administration of the system was centralized by the establishment of the office of state engineer to supervise the work of the local commissioners. Twelve *Biennial Reports* have been published by the state engineer, the last being for 1904. Since the act of April 4, 1887, this official has had the duty of adjudicating and surveying disputed boundaries (*Sess. Laws*, 1879, p. 94; 1881, p. 119; 1887, p. 288).

[2] The erection of Platte county was authorized, subject to popular vote, February 9, 1872 (*Sess. Laws*, 1872, p. 80). This statute was repealed February 9, 1874 (*Sess. Laws*, 1874, p. 82). The courts have decided that such a popular vote is not a constitutional prerequisite to the formation of a new county, although it is necessary in cases of transfer of land from one existing county to another (*Frost v. Pfeifer*, *XXVI Colorado* 338). There is a general statute of April 4, 1887, for alteration of county lines in certain cases by mutual consent of adjacent counties (*Sess. Laws*, 1887, p. 71.)

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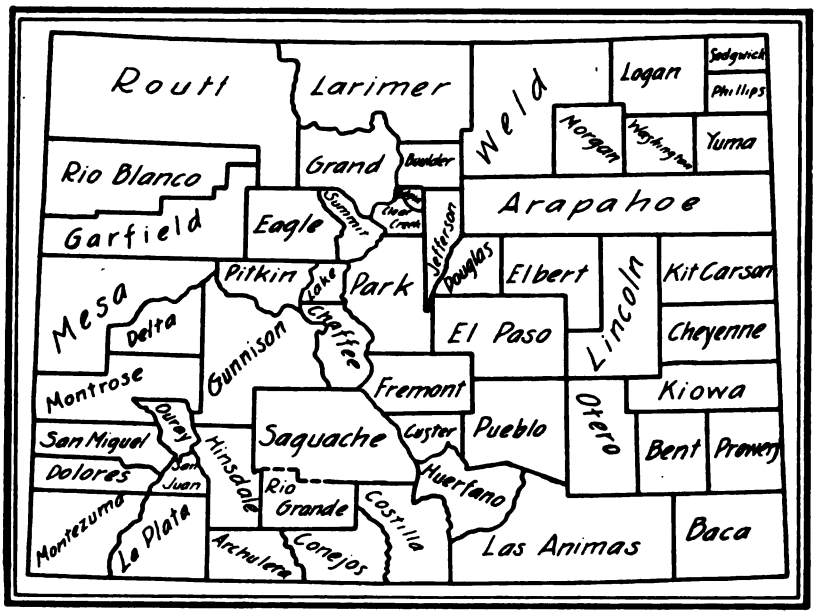

MAP XIII.—1889—Seventh General Assembly.

erected two counties of Logan and Washington, and began the process of the final subdivision of the east.[1]

The seventh assembly, in 1889, created eleven counties on the eastern border of the state.[2] Logan parted with its eastern end to endow Sedgwick and Phillips; Yuma was erected in the eastern end of Washington; while Weld gave up, as its last contribution, the area of Morgan. South of Arapahoe, which came through the assembly untouched, perhaps because its eastern end contained no railways to develop the country or to pay taxes for new counties, Elbert and Bent suffered most in the division. From Elbert came Kit Carson and a part of Cheyenne on the Kansas line, with the greater part of Lincoln; while

[1] Washington, February 9; Logan, February 25, 1887 (*Sess. Laws*, 1887, pp. 251, 247).

[2] A study of this county expansion in connection with the railway development of the eighties shows the intimate relation existing between railway transportation and frontier development. A state commissioner of railroads was created in 1885 (*Sess. Laws*, 1885, p. 307). Two reports were published by this official in 1885 and 1892, and finally the office was abolished over the veto of Governor Waite in 1893 (*Sess. Laws*, 1893, p. 405; DAVIS H. WAITE, *Biennial Message . . . . to the Tenth General Assembly* [Denver, 1895], p. 43). The *Eleventh Census. Report on Transportation Business*, Part I, pp. 4, 43, states that railroad mileage in Colorado increased from 1,385 in 1880 to 4,176 in 1890.

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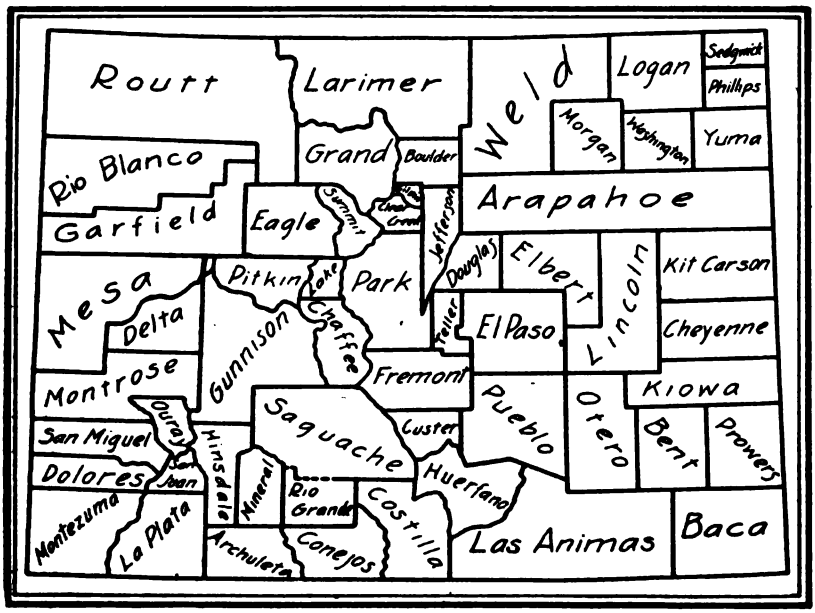
Bent not only contributed to complete Lincoln and Cheyenne, but parted with three complete counties in Kiowa, Prowers, and Otero. Las Animas lost Baca in this same destruction, giving up the one county of the eastern border with no railway in its endowment.[1]



MAP XIV.—1899—Eighth to Twelfth Assemblies.

There was little left to be done on the eastern slope after the comprehensive accomplishments of the seventh assembly. Ten years later, in 1899, the twelfth assembly took the next step in response to the demands of the new Cripple Creek camp, creating Teller county at the expense of El Paso and Fremont.[2]

[1] Morgan, February 19, 1889 (*Sess. Laws*, 1889, p. 267); Yuma, March 15 (p. 476); Cheyenne, March 25 (p. 56); Otero, March 25 (p. 281); Phillips, March 27 (p. 288); Sedgwick, April 9,(p. 340); Prowers, April 11 (p. 294); Kiowa, April 11 (p. 222); Kit Carson, April 11 (p 225); Lincoln, April 11 (p. 234); Baca, April 16 (p. 26).

[2] Act of March 23, 1899 (*Sess. Laws*, 1899, p. 359). The difficulties in administering a county containing, as in the case of El Paso, two large centers of population, Colorado Springs and Cripple Creek, were made clear during the great strike of 1893–94 (B. M. RASTAL, "The Cripple Creek Strike of 1893," in *Colorado College Studies*, Vol. II, pp. 1–48). The case of *Frost v. Pfeiffer*, cited above, was decided in connection with the creation of this county (XXVI Colorado, 338). The western line of Teller had been run, on appeal o El Paso and Park, in 1893 (*Colorado State Engineer, Seventh Biennial Report*, p. 221.

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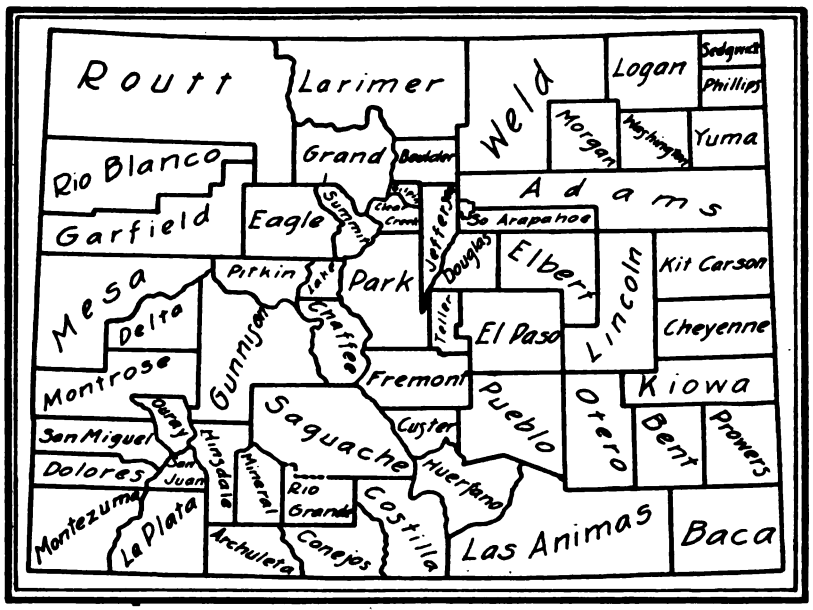
The thirteenth assembly was induced by the needs of the city of Denver to prepare a constitutional amendment providing a special type of government for counties of more than seventy thousand inhabitants, and a statute erecting the city and county of Denver as coterminous



MAP XV.—1901—Thirteenth Assembly.

divisions.[1] It provided also that upon the acceptance of this amendment on November 4, 1902, the remainder of Arapahoe county should become Adams and South Arapahoe.[2] Two years later the fourteenth assembly cut away from the cumbersome Adams county, and gave vigor to the notion of the necessity of the railroad to county life by adding portions of the discarded Adams to Washington and Yuma.[3]

[1] Act of March 18, 1901 (*Sess. Laws*, 1901, p. 97; DAVID A. MILLS, *Legislative Manual, State of Colorado*, 1903, p. 267).

[2] Acts of April 15, 1901 (*Sess. Laws*, 1901, pp. 133, 138).

[3] Acts of April 10, 1903 (*Sess. Laws*, 1903, pp. 169, 173).

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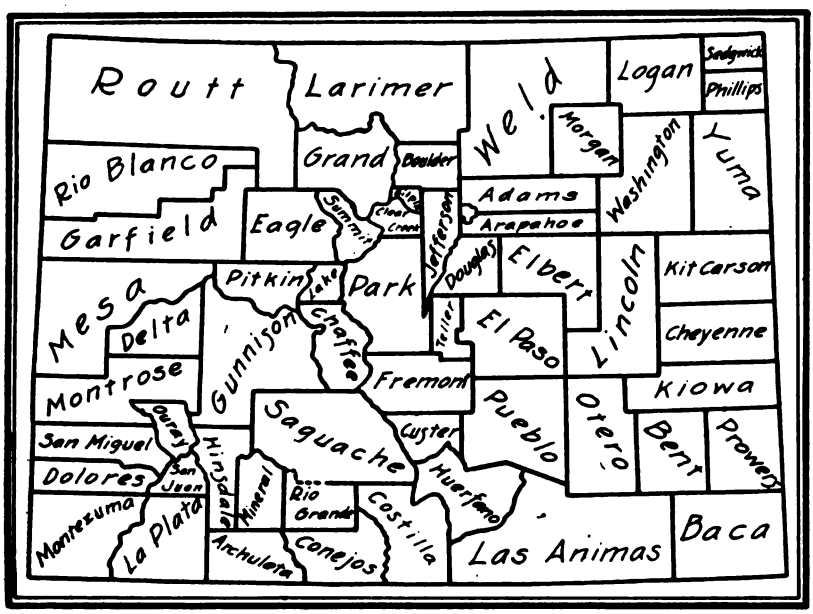
The fifteenth assembly, in 1905, made no territorial changes, ignoring some demand for a new county in North Park at the expense of Larimer, and devoting itself to the administrative problems arising from the strikes of the preceding year.



MAP XVI.—1903—Fourteenth Assembly.

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LUCRETIUS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE

By Fred B. R. Hellems

Part II[1]

(1) The Existence of God. (2) The Freedom of the Will. (3) The Nature of Matter and the Origin of Motion. (4) The Origin of Life. (5) The (Apparently Preordained) Orderly Arrangement of Nature. (6) The Origin of Simple Sensation and Consciousness. (7) Rational Thought and the Origin of the Cognate Faculty, Speech.

In our approach to the remaining riddles we ought to be on our guard against expecting such practically complete agreement as we have found in examining the central problem; but we shall find no lack of close and suggestive similarity.

1. The Existence of God

The idea of a "ruling, creating, sustaining God" is opposed by Haeckel and Lucretius with the same ardor, but with a different attitude. Haeckel treats all theism as "mystic dualistic dogma, a mere anthropistic ideal," and dismisses it as a vanished fabric of a dream.[2] He naturally turns to pantheism as the world-system of the modern scientist.

That Lucretius had, "in the same or an analogous sense, a profound conception of the unity of nature and God" has been pointed out by Haeckel himself, and the fact need not be enlarged upon. It is worth recalling, however, that Lucretius nowhere absolutely denies the existence of the gods, and, indeed, speaks of their existence and even of "their revealing themselves to the mind of man."[3] He rationalizes about them and allows them a lotos-eating sort of existence, for all that is necessary for his purpose is the elimination of their interference in the affairs of the universe; and a brilliant critic has most felicitously compared his treatment of the gods to the treatment of rebel potentates in the East, where the kings are left to the people after being ceremonial-

[1] Part I, "The Immortality of the Soul," appeared in the preceding number of the *Studies*.

[2] *WR.*, 275 *seq.*

[3] See a concise and lucid account in Sellar, *Roman Poets of the Republic*, 364 *seq.*

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ized into harmlessness. That Lucretius really believed in even this dreamy existence of the gods I am strongly inclined to doubt; but even if he did, it is hardly necessary to point out that gods who are rationalized into distant, graceful, non-interfering spectators of the march of the universe are for all practical purposes the same as no gods at all. The attitude of such a rationalist may even be more atheistic in effect than atheism itself.[1]

2. THE FREEDOM OF THE WILL[2]

In theory Haeckel is an unconditional determinist, because he is an unconditional scientist.[3] His conclusion runs: "The great struggle between the determinist and the indeterminist, between the opponent and the sustainer of the freedom of the will, has ended today, after more than two thousand years, completely in favor of the determinist. The human will has no more freedom than that of the higher animals, from which it differs only in degree, not in kind. In the last century the dogma of liberty was fought with general philosophic and cosmological arguments. The nineteenth century has given us very different weapons for its definitive destruction—the powerful weapons which we find in the arsenal of comparative physiology and evolution. We now know that each act of the will is as fatally determined by the organization of the individual and as dependent on the momentary condition of his environment as every other psychic activity. The character of the inclination was determined long ago by *heredity* from parents and ancestors; the determination to each particular act is an instance of *adaptation* to the circumstances of the moment wherein the strongest motive prevails, according to the laws which govern the statics of emotion. Ontogeny teaches us to understand the evolution of the will in the individual child. Phylogeny reveals to us the historical development of the will within the ranks of our vertebrate ancestors."

With this Lucretius, for all his thoroughgoing atomism, could not

[1] Compare Mr. Gladstone's vigorous presentation and condemnation of the Lucretian attitude in modern life. He quoted the six "plangent" lines (II, 646–651) with tremendous effect in a speech that both Mr. Bryce and Mr. Morley select as one of the most impressive of his later efforts. Vide MORLEY, *Life of Gladstone*, III 18–20; and *The Quarterly Review*, September, 1903.

[2] For the current interest about this question in scientific circles, and an attempt at a combination of monism with this postulate of practical reason, see W. H. MALLOCK, "The Reconstruction of Religious Belief" (Harper's, 1905), particularly pp. 354 *seq.*

[3] *WR.*, 129–131.

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quite agree. An English writer has pointed out that Lucretius, having escaped from the arbitrary dominion of the gods and found himself confronted by the yet more terrible phantasm of necessity transforming man into a slave, a mere machine of fate, resorted to a bold and simple expedient: "I cannot account for the free-will appearing in human beings unless it were there from the first. If men have free-will, then the atoms from which they come must have free-will too, since nothing comes from nothing." This embryonic free-will is seen in the swerving of the atoms. After insisting on the necessity of assuming that the atoms have power to swerve the least tiny bit, *nec plus quam minimum*, he proceeds:[1] "Again if all motion is ever linked together and a new motion ever springs from another in a fixed order and first beginnings do not by swerving make some commencement of motion to break through the decrees of fate, that cause follow not cause from everlasting, whence have all living creatures here on earth, whence, I ask, has been wrested from the fates the power by which we go forward whither the will leads each, by which likewise we change the direction of our motions neither at a fixed time nor a fixed place, but when and where the mind itself has prompted? For beyond a doubt in these things his own will makes for each a beginning and from this beginning motions are welled through the limbs. . . . . Wherefore in seeds [i. e., atoms] too you must admit the same, admit that besides blows and weights there is another cause of motion, from which this power of free action has been begotten in us, since we see that nothing can come from nothing. For weight forbids that all things be done by blows, through, as it were, an outward force; but that the mind itself does not feel an internal necessity in all its actions and is not, as it were, overmastered and compelled to bear and put up with this, is caused by a minute swerving of first-beginnings at no fixed part of space and no fixed time."[2] In this connection Lucretius admits fully the power of heredity: "However much teaching renders some equally refined, it yet leaves behind those earliest traces of the nature of each mind;" but he insists on the power of reason to modify the natural disposition. "Traces of the different natures left behind, which reason is unable to expel from us, are so exceedingly slight that there is nothing to hinder us from living a life

[1] *De R. N.*, II, 243–250. [2] *Ibid.*, II, 251–293.

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worthy of the gods."[1] To this Haeckel would rejoin that our very reason is a product of our heredity and environment.[2]

3. The Nature of Matter and the Origin of Motion

We may now return to the order of the riddles originally given above taking up together the first, as to the nature of matter, and the second, as to the origin of motion.

Under the "Law of Substance"[3] Haeckel embraces the chemical law of the conservation of matter and the physical law of the conservation of energy. The former we have in Lucretius as his fundamental tenet: "Nothing can come from nothing and nothing returns to nothing;"[4] the latter is, of course, purely modern. Haeckel comes, then, to two fundamental forms of substance, ponderable matter and ether, whereas Lucretius has matter and void. As to the nature of the ultimate particles of substance, Haeckel inclines to the theory put forth by J. C. Vogt, and we may let him state it in his own words:[5]

> Vogt assumes the primitive force of the world, the universal *prodynamis*, to be, not the vibration or oscillation of particles in empty space, but the condensation of a simple primitive substance, which fills infinity of space in an unbroken continuity. Its sole inherent mechanical form of activity consists in a tendency to condensation or contraction, which produces infinitesimal centers of condensation; these may change their degree of thickness, and, therefore, their volume, but are constant as such. These minute parts of the universal substance, the centers of condensation, which might be called *pyknatoms*, correspond in general to the ultimate separate atoms of the kinetic theory; they differ, however, very considerably in that they are credited with sensation and inclination (or will-movement of the simplest form), *with souls*, in a certain sense—in harmony with the old theory of Empedocles of the "love and hatred of the elements." Moreover, these "atoms with souls" do not float in empty space, but in the continuous, extremely attenuated, intermediate substance, which represents the uncondensed portion of the primitive matter. By means of certain "constellations, centers of perturbation, or systems of deformation," great masses of centers of condensation quickly unite in immense proportions, and so obtain a proponderance over the surrounding masses. By that process the primi-

[1] *De R. N.*, III, 307–322.

[2] With regard to Haeckel's statement that higher animals have as much claim to possess freedom of the will as have human beings, it should be noted that Lucretius holds the same view; he allows a certain freedom to both, Haeckel to neither. *De R. N.*, II, 263 *seq.*, in connection with the context; *WR.*, 131..

[3] *WR.*, 211 *seq.*

[4] *De R. N.*, I, 149, 150, *et passim.*

[5] *WR.*, 218–219.

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tive substance, which in its original state of quiescence had the same mean consistency throughout, divides or differentiates into two kinds. The centers of disturbance, which *positively* exceed the mean consistency in virtue of the *pyknosis* or condensation, form the ponderable matter of bodies; the finer, intermediate substance, which occupies the space between them, and *negatively* falls below the mean consistency, forms the ether, or imponderable matter. As a consequence of this division into mass and ether there ensues a ceaseless struggle between the two antagonistic elements, and this struggle is the source of all physical processes. The positive ponderable matter, the element with the feeling of like or desire, is continually striving to complete the process of condensation, and thus collecting an enormous amount of potential energy; the negative, imponderable matter, on the other hand, offers a perpetual and equal resistance to the further increase of its strain and of the feeling of dislike connected therewith, and thus gathers the utmost amount of *actual* energy.

The primal atoms of Lucretius are known well enough. They are indestructible, eternal, indivisible—except metaphysically into *minimas partes*—of various shapes, infinite in number, moving continuously in infinite space. The various qualities of material things are the results of accidental combinations of the atoms, and we have seen that even the human mind and soul are included in this reckoning. In view of the importance of the atomic motion just mentioned, we may quote the following:

If you think that first-beginnings of things can lag and by lagging give birth to new motions of things, you wander far astray from the path of true reason: since they travel about through void, the first-beginnings of things must all move on either by their own weight or haply by the stroke of another. For when during motion they have, as often happens, met and clashed, the result is a sudden rebounding in an opposite direction; and no wonder, since they are most hard and of weight proportioned to their solidity and nothing behind gets in their way. And that you may more clearly see that all bodies of matter are in restless movement, remember that there is no lowest point in the sum of the universe, and that first bodies have not where to take their stand, since space is without end and limit and extends immeasurably in all directions round, as I have shewn in many words and as has been proved by sure reason. Since, then, this is a certain truth, sure enough no rest is given to first bodies throughout the unfathomable void, but driven on rather in ceaseless and varied motion they partly, after they have pressed together, rebound, leaving great spaces between them, while in part they are so dashed away after the stroke as to leave but small spaces between. And all that form a denser aggregation when brought together and rebound leaving trifling spaces between, held fast by their own close-tangled shapes, these form enduring bases of stone and unyielding bodies of iron and the rest

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of their class, few in number, which travel onward along the great void. All the others spring far off and rebound far leaving great spaces between: these furnish us with thin air and bright sunlight. And many more travel along the great void, which have been thrown off from the unions of things or, though admitted, have yet in no case been able likewise to assimilate their motions. Of this truth, which I am telling, we have a representation and picture always going on before our eyes and present to us: observe whenever the rays are let in and pour the sunlight through the dark chambers of houses: you will see many minute bodies in many ways through the apparent void mingle in the midst of the light of the rays, and as in never-ending conflict skirmish and give battle, combating in troops and never halting, driven about in frequent meetings and partings; so that you may guess from this, what it is for first-beginnings of things to be ever tossing about in the great void. So far as it goes, a small thing may give an illustration of great things and put you on the track of knowledge. And for this reason too it is meet that you should give greater heed to these bodies which are seen to tumble in the sun's rays, because such tumblings imply that motions also of matter latent and unseen are at the bottoms. For you will observe many things there impelled by unseen blows to change their course, and driven back, to return the way they came, now this way and now that way in all directions round. All you are to know derive this restlessness from the first-beginnings. For the first-beginnings of things move first of themselves, next those bodies which form a small aggregate and come nearest, so to say, to the powers of the first-beginnings, are impelled and set in movement by the unseen strokes of those first bodies, and they next in turn stir up bodies which are a little larger. Thus motion mounts up from the first-beginnings and step by step issues forth to our senses, so that those bodies also move, which we can discern in the sunlight, though it is not clearly seen by what blows they so act.[1]

As to the "Origin of Motion," then, the theory of either scientist is simply a part of his conception of matter, as has doubtless been noticed in reading the preceding paragraphs. Lucretius merely posits motion as a property of his ultimate particles, and Haeckel practically does the same when he insists on the "tendency to condensation or contraction" in Vogt's primitive substance.[2]

In connection with the nature of matter it would seem desirable to discuss briefly one point, the character of the atom as related to the problem of consciousness. Both Haeckel and Lucretius state that consciousness has a material, and therefore an atomic, basis;[3] but the former has

[1] *De R. N.*, II, 80–141.

[2] Cf. *WR.*, 241: "In our opinion this second world-enigma is solved by the recognition that movement is as innate and original a property of substance as is sensation."

[3] See p. — of this article.

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always denied any individual consciousness to the atom, and the latter refuses to attribute thereto any sensation whatever.[1] But here is our old crux as to *ex nihilo nihil fit*, and Haeckel, as we have seen, does attach "the elementary qualities of sensation and will" to his first-beginnings. Apparently, then, Haeckel is a consistent monist and Lucretius a benighted materialist; but in reality this "unconscious possession of sensation and will," manifested so early in matter as tropisms, and the power to swerve possessed by the Lucretian atoms, making a break in the endless chain of causation, may eventually appear to metaphysical examination much closer together than they seem at first sight.

4. The Origin of Life

The question of the origin of life is still approached with no little diffidence by many advanced scientists; but for Haeckel and Lucretius there is no doubt nor shadow of turning.[2] In the tender age of the world, when there were conditions of heat and moisture scarcely conceivable by us, life was generated spontaneously by the earth, which has "rightly gotten the name of mother." Some combination of particles under just the proper condition was the origin of organic life. These two sentences would be a fair statement of the fundamental position of either writer; but the orderly development of organisms through the crudest protoplasmic forms is of course a purely modern conception.[3] Lucretius can guess that nature essayed the creation of all sorts of living creatures which died out because they were unable to beget and continue their breed, and in one sense this is a theory of the survival of the fittest; but it should not be confused with the elaborately supported modern hypothesis. It is very strange, however, almost incredible, indeed, that with the suggestions of Lucretius available for modern science the formulation of this all important hypothesis came so late.

5. The Orderly Arrangement of Nature

When we come to the (apparently preordained) orderly arrangement of nature, we naturally find both writers immediately rejecting any "divine,

[1] *De R. N.*, II, 865 *seq.*

[2] In the *WR.* see the first part of "The Unity of Nature" (chap. xiv) and the latter part of "The Evolution of the World" (chap. xiii); in the *De R. N.* see Book V, particularly vss. 416–924.

[3] Particularly significant of the difference in the method of approach of our two writers and of the data available for their use is the statement of the carbon theory of abiogenesis or archigony in *WR.*, 256 *seq.*

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supernatural, telic force." "All things are done without the hands of the Gods."[1] Indeed, as we have already seen, the *De Rerum Natura* and the *Welträthsel* were put forth to deny the operation of any external ruler, so that an adequate treatment of this fourth enigma would demand an exhaustive exposition of both books, and there is something appurtenant to this section in every topic we have touched upon. Accordingly, we shall have to pass over the more general phases; but the argument from disharmonies, to borrow a word from Metchnikoff, demands some notice, inasmuch as both men make it especially significant.

"But if I did not know what first-beginnings of things are, yet judging by the very arrangements of heaven I would venture to affirm, and led by many other facts to maintain, that the nature of things has by no means been made for us by divine power; so great are the defects with which it is encumbered." Thus Lucretius writes,[2] and then enumerates a few of the defects: the comparatively small part of the world profitably habitable by man, the difficulty of tillage, the tendency of food-producing plants to degenerate, disease, untimely death—the great disharmony—the helplessness of the human offspring as contrasted with the young of beasts. "Throughout the whole of astronomy, geology, physics, and chemistry there is no question today of a 'moral order,' or 'a personal God whose hand hath disposed all things in wisdom and understanding,'" says Haeckel, and then turns with the same spirit to the history of peoples and of humanity and to the fate of individual human beings, the catastrophes and accidents of modern daily life. "And among these hundreds of thousands of animal victims of modern civilization, strong, industrious, courageous workers predominate. Yet the talk of a 'moral order' goes on."[3] Haeckel, of course, can give all the arguments of Lucretius and add thereto all the significant instances of dysteleology in modern biology. "All the higher animals and plants, or, in general, all organizations which are not entirely simple in structure, but are made up of a number of organs in orderly co-operation, are found, on close examination, to possess a number of useless or inoperative members, sometimes, indeed, hurtful and danger-

[1] *De R. N.*, I, 158, *et passim; WR.*, 258 *seq.*, *et passim.*

[2] *De R. N.*, V, 195–199; *cf.* 177–181.

[3] *WR.*, 273.

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ous;" and the now ubiquitous appendix is honorably prominent at the end of the enumerated instances.

6. The Origin of Simple Sensation and Consciousness

Upon the origin of simple sensation and consciousness, the fifth enigma, we have alread touched so that we may make our treatment very brief. Lucretius,[1] posits an atom without sensation, *insensile*, and states that from these insensible primordia arise all things capable of sensation. Atoms of the same sort in different arrangements give us inert logs and leaping flames and vital parts that can feel. He adduces in evidence the childish belief that worms may arise from heaps of inanimate filth, and the change in the nature of material when grass becomes part of the bodies of animals and these in turn part of our frame, or we a part of theirs. That is, he argues that nature has a power of turning inanimate matter into living substance capable of sensation, or, to advance a couple of thousand years for a word, into protoplasm. He asks how eggs can be changed into birds unless sensible things can arise from insensible.[2] Sensation in the human frame, he goes on, disappears when the arrangement of the atoms is disturbed by a powerful blow, so it must be due merely to that arrangement. Again, if the blow was not strong enough to cause death, the original arrangement of the atoms in the frame is gradually brought about again and sensation returns. "So that you may know that it is of great import with what first-beginnings the same first-beginnings are combined and in what arrangement, and what motions they mutually give and receive."[3]

For Haeckel the answer to the present riddle is found in the nature of his ultimate substance. The pyknatoms are credited with a certain sensation and inclination, so that he finds no difficulty in the development of

1 *De R. N.*, II, 865–1022.

2 *Cf.* Huxley in *Science and Christian Tradition:* "Granted a fowl feels; that the chick just hatched feels, that the chick when it chirps within the egg may possibly feel; what is to be said of it on the first day, when it is nothing but a flat cellular disk? I certainly cannot bring myself to believe that this disk feels. Yet if it does not there must be some time in the three weeks between the first day and the day of hatching, when as a concomitant, or a consequence of the attainment by the brain of the chick of a certain stage of structural evolution, consciousness follows."

3 It will be noticed that Lucretius does not use the power of swerving in the atom as a starting-point for sensation and consciousness; the explanation probably is that he did not feel it necessary in this connection, whereas for his doctrine of the freedom of the will it is indispensable.

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less simple sensation. All sensibility is connected with material changes in the protoplasm.[1] In the lowest animals and in plants the psychoplasm, the indispensable substratum of any psychic activity, has not reached an independent differentiation. He then gives five chief stages of sensibility from the point at which the whole psychoplasm is sensitive to the point at which "*conscious perception* is developed by the mirroring of the sensations in a central part of the nervous system, as we find in man and the higher vertebrates, and probably in some of the higher invertebrates, notably the articulata."

Both writers, then, hold that the origin of simple sensation and consciousness is connected with the arrangement of the ultimate particles of substance. Lucretius maintains that sensibility may arise from insensible atoms; whereas Haeckel attributes to his atoms the simplest form of sensation. Both, of course, deny any divine interposition at the point where it is so often demanded, the origin of consciousness.[2]

7. Rational Thought and the Origin of the Cognate Faculty, Speech

Recalling our treatment of the preceding topic and of the immortality of the soul, it is hardly necessary to state that for both Haeckel and Lucretius rational thought is simply the culmination of our psychic gradations.

As to the origin of language Haeckel[3] is contented to point out that "here also we have to recognize a long chain of evolution which stretches unbroken from the lowest to the highest stages. Speech is no more an exclusive prerogative of man than reason. In the wider sense it is a common feature of all the higher gregarious animals, at least of all the articulata and the vertebrates, which live in communities or herds. This is effected either by touch or by signs, or by sounds having a definite meaning. The song of the bird or of the anthropoid ape (*Hylobates*), the barking of the dog, the neigh of the horse, the chirp of the cricket, the cry of the cicada, are all specimens of animal speech. Only in man, however, has that articulate conceptual speech developed which has enabled

[1] *WR.*, 108 *seq.*

[2] Their views as to consciousness in its higher forms have been compared in Part I of the paper in the preceding number of the *Studies*.

[3] *WR.*, 126.

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his reason to attain such high developments." Others have worked out the theory of linguistic evolution in such detail that he has only to summarize their results. Lucretius, however, was not so fortunate, and he writes at greater length as follows:

But nature impelled them to utter the various sounds of the tongue and use struck out the names of things, much in the same way as the inability to speak is seen in its turn to drive children to the use of gestures, when it forces them to point with the finger at the things which are before them. For everyone feels how far he can make use of his peculiar powers. Ere the horns of a calf are formed and project from his forehead, he butts with it when angry and pushes out in his rage. Then whelps of panthers and cubs of lions fight with claws and feet and teeth at a time when teeth and claws are hardly yet formed. Again we see every kind of fowl trust to wings and seek from pinions a fluttering succour. Therefore, to suppose that some one man at that time apportioned names to things, and that men from him learnt their first words, is sheer folly. For why should this particular man be able to denote all things by words and to utter the various sounds of the tongue, and yet at the same time others be supposed not to have been able to do so? Again if others as well as he had not made use of words among themselves, whence was implanted in this man the previous conception of its use and whence given to him the original faculty to know and perceive in mind what he wanted to do? Again one man could not constrain and subdue and force many to choose to learn the names of things. It is no easy thing in any way to teach and convince the deaf of what is needful to be done; for they never would suffer nor in any way endure sounds of voice hitherto unheard to continue to be dinned fruitlessly into their ears. Lastly, what is there so passing strange in this circumstance, that the race of men, whose voice and tongue were in full force, should denote things by different words as different feelings prompted? Since dumb brutes, yes, and the races of wild beasts are accustomed to give forth distinct and varied sounds when they have fear or pain and when joys are rife. This you may learn from facts plain to sense; when the large, spongy, open lips of Molossian dogs begin to growl enraged and bare their hard teeth, thus drawn back in rage they threaten in a tone far different from that in which they bark outright and fill with sounds all the places round. Again when they essay fondly to lick their whelps with their tongue, or when they toss them with their feet and snapping at them make a feint with lightly closing teeth of swallowing though with gentle forbearance, they caress them with a yelping sound of a sort greatly differing from that which they utter when, left alone in a house, they bay or when they slink away howling from blows with a crouching body. Again is not the neigh, too, seen to differ, when a young stallion in the flower of age rages among the mares smitten by the goads of winged love, and when with wide-stretched nostrils he snorts out the signal to arms, and when as it chances on any other occasion he neighs with limbs all shaking? Lastly, the race of fowls

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and various birds, hawks and osprays and gulls seeking their living in the salt water mid the waves of the sea utter at a different time noises widely different from those they make when they are fighting for food and struggling with their prey. And some of them change together with the weather their harsh croakings as the long-lived races of crows and flocks of rooks when they are said to be calling for water and rain, and sometimes to be summoning winds and gales. Therefore, if different sensations compel creatures, dumb though they be, to utter different sounds, how much more natural it is that mortal men in those times should have been able to denote dissimilar things by many different words![1]

In running over these lines one readily notes that Lucretius agrees with modern views in assigning language to both beasts and birds; that he insists upon a *pari passu* development of a number of primitive ancestors; and that he thinks of the evolution of language as absolutely simple and natural.

In conclusion, I may answer the question of a friend as to what ends the foregoing paper, including the sections on "The Immortality of the Soul," was intended to serve. To begin with, we stand at the parting of the ways.—The human race, however, always does stand at a parting of the ways, and, I suppose, always will.—Monism and dualism are distinct paths claiming to lead us onward and upward to the highest planes of moral life and intellectual thought, and one of these paths every thinking man must follow. At such a time it might seem worth while to consider monism at two significant points in its historical development, in the hope of gaining some little knowledge, at any rate, as to the line as well as the extent of its advance. That Haeckel and Lucretius conveniently represent two such points is obvious. Again, I take it to be true that a comparison of the views of two master-minds on a series of momentous questions is never without some profit. Furthermore, the hard-working teachers of science and of classics often wish to bring together the two stages of thought represented by our authors, and for them I have tried to make such a comparison easily available. That the method of quoting so extensively is open to criticism I am well aware; but I have preferred to stand aside and let the recorded words speak for themselves. From a man's own words one may learn his thoughts, whereas an interpreter is often misleading, if not misled.

[1] *De R. N.*, V 1028–1090.

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SHAKESPEARE AND PSYCHOGNOSIS

ESSAY II. MAJOR CHARACTERS OF "THE TEMPEST"[1]

By Melanchthon F. Libby

Ariel: Ideal Type

As Ariel is called "An Airy Spirit," it might be supposed that his character would defy the inductive method of criticism. But in reality he appears in six of the nine scenes, and many plain but significant facts can be stated concerning his words, actions, and relations to others. He appears in the second, third, sixth, seventh, eighth, and ninth scenes. The thunder and lightning of the first scene are the work of Ariel; or, if one judge by his words to Prospero in scene ii, he is, rather than makes, the lightning. In the second scene we learn that he is Prospero's servant; that he comes to him at his master's wish and command. Without further message, he respects the authority of the grave and learned Prospero. He has remarkable powers over nature, being able to fly, swim, dive into fire, ride on clouds. He has "performed to point" a tempest with terrible accompaniments of lightning, thunder, wind, and wave. Through these dramatic means he has moved men to tricks of desperation. He has dispersed the shipwrecked men in troops about the island. He speaks with vivid powers of narration, and of his own initiative mimics the attitude of the despairing Ferdinand. He has dispersed a fleet.[2]

At the mention of more toil he becomes moody. He demands his liberty, desiring to follow the play-instinct, and not to serve the ends of his moral and intellectual master. He speaks boldly of the worth to Prospero of his service, which he describes as truthful, free from mistakings, and free from grumblings.

Prospero, with habitual severity, says nothing in reply to this claim. He proceeds to read Ariel a lesson of gratitude, in the course of which we learn something of the spirit's history.

Prospero gives us more facts about Ariel: he can walk the bed of the ocean, face the cold of the north, penetrate the veins of the frozen earth. Ariel was the servant of Sycorax before he was the servant of Prospero. This extraordinary fact is fully emphasized. But the gross nature of the ancient rites of Sycorax roused deep revolt in Ariel. For his rebellion he was horribly punished, being imprisoned in a cloven pine, for a dozen years. Sycorax died. Then came an interval during

[1] Essay I, "The Minor Characters of the Tempest," appeared in No. 2 of this volume of *University of Colorado Studies*, p. 63.

[2] This figure may have been suggested by the popular idea of the time concerning the protection of England from the Armada.

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which the freckled hag-born whelp, Caliban, was the only human being on the island. Ariel showed himself capable of feeling pain by his groans. His groan moved wolves to howl, a strong comparison as Shakespeare uses words: "It was a torment to lay upon the damned."[1]

It was Prospero's art, gained by the bettering of his mind by study, that enabled him to free Ariel from between the forks of the tree. If the freed spirit now declines to assist his learned master in his labors, the master will peg him in the knotty entrails of an oak for twelve years more. Prospero does not deny Ariel's right to liberty. He denies that Ariel should yet assert that right. Ariel acquiesces and begs his master's pardon.

Ariel's name in the *Dramatis Personae* is entered after Miranda's, not among the male characters. In the play he is only *once* referred to by a masculine word.[2] Prospero commands him to assume the form of a nymph, and to render himself invisible to all but his master. These two powers, of assuming any desired form and of being invisible, are accepted and used by Shakespeare as facts suitable to the conception of a spirit.

When Ariel reappears like a water-nymph, Prospero gives the spirit a command. It is not clear why the form of a water-nymph was required, for when Ariel enters, followed by Ferdinand, he is heard singing, but not seen. Perhaps, as he is to sing like a water-nymph, he must assume that part in its entirety. The first song is an expression of the free play-instinct; with lyrics of the moral and intellectual realm it has no relation; it expresses no interest in anything except the interest of pure, disinterested love of the beautiful. It is unique in its freedom from thought or purpose. It has the suggestion of the passing of night and the coming of dawn, which should enhance its beauty to those who might find its clear, dim, peaceful pictures and far away beautiful sounds insipid.

The second song is also mystical and unearthly. The light, emotionless treatment of death, so remote from commonplace dirges, suggests that to the spirit this world is but a passing show and death no more than the dropping of the curtain between acts. It has the note of infinity in a remarkable degree. There is no human pathos in the line, "those are pearls that were his eyes," yet it is not coarse or harsh. Ariel is speaking of human vicissitude under the forms of the eternal. Only from such a point of view is it true that whatever is, is right, and from a station above passion and sympathy it is sufficient to say to Ferdinand mourning for his father,

> "Nothing of him that doth fade,
> But doth suffer a sea-change
> Into something rich and strange."

Ferdinand's comment on the poem is the best criticism. "This is no mortal busi-

[1] Hartmann's conception of a suffering god.

[2] In Renan's *Caliban* Ariel is female.

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ness, nor no sound that the earth owes: I hear it now above me." It is precisely at this point that Prospero says,

"The fringed curtains of thine eye advance,
And say what thou seest yond."

At this moment Miranda and Ferdinand fall in love, and thus the mortal is linked to the spiritual in the very center of the plot. Ariel has roused in Ferdinand a profound spiritual craving, and, as his eyes fall upon Miranda, he exclaims: "Most sure the goddess on whom these airs attend!" It is in this that natural magic is seen to be seated.[1] Prospero thanks Ariel for his service in bringing Ferdinand in this way: Prospero here controls human life at its fountain:

"Spirit, fine spirit, I'll free thee
Within two days for this."

Prospero attaches very serious importance to the high romantic art of the fantastical spirit, and its influence upon this pair of children. "Miranda is fifteen, and Ferdinand presumably not much older." He afterwards exclaims again: "Delicate Ariel, I'll set thee free for this." As if in some mysterious way the freeing of the spirit depended upon the success of true love, and true love depended upon the labors of the spirit.[2]

At the close of the scene Ariel receives a new command, which he promises to obey to the syllable.

It appears from the scene that, though Ariel is a spirit, his character is firmly outlined by words, actions, and descriptive narration. He possesses powers over the elements of physical nature far transcending those of science as known to Shakespeare, or even as known today. He exercises these powers, as far as can be learned, immediately, not mediately. This is his peculiar gift as a spirit. He prefers play to labor, and has no initiative in useful effort, but in mimicry or play he shows pleasurable activity; restraint makes him moody and low-spirited. What he agrees to do he does satisfactorily in every respect; but it seems he would do anything else with equal exactness, if Prospero commanded it. Uncontrolled, he would play, like Puck. As far as his story extends, he has been a servant or a prisoner. When the service was too distasteful, he rebelled, to his cost. It was through learning that he became comparatively free. He therefore owes it to learning to lend his powers to its further needs. There is danger of a worse fate if he refuses, which is a course within his choice.

His power extends to his own form, which he can change or render invisible.

His songs are marked by two distinct characteristics—the pure love of mere beauty—as music, dancing, landscape, joyous playfulness; and the note of remote-

[1] Cf. Kipling's "To the true Romance."

[2] The pedagogy that aims at modifying environment leaves the raw material of education to chance. The control of selection by science, however impossible at present, can alone bring the evolution of man within the control of knowledge.

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ness from mortal sympathies and purposes. This note of infinity is the most characteristic fact about Ariel. His cool, beautiful explanation of death, the deepest of human terrors, as a phenomenon of progress, is not inhuman but superhuman. This superhuman point of view makes his lack of human feeling assume a new and different aspect. Prospero treats him as if he had absolute respect for his power, genius, purity, but as if he felt the need of using and directing his power because of Ariel's freedom from the sense of duty. Ariel treats Prospero as if he respected his gravity, learning, purpose; but as if his austere control were irksome, and his purposes a bore. Ariel's understanding and bitter experience convince him that his liberty depends upon obedience to the orders of the day, and the promise that liberty is near makes him more and more willing.

The first labor of Ariel was the raising of the storm and the dispersion of the shipwrecked mariners. His second labor was the bringing of Ferdinand to Miranda. His third labor was the rousing of Gonzalo in the third scene. In this as in the others he is executing the commands of Prospero. He says:

"My master through his art foresees the danger
That you, his friend, are in; and sends me forth
For else his project dies—to keep thee living."

He recognizes Gonzalo as the friend, and Antonio and Sebastian as the enemies of Prospero.

His song to the sleeping Gonzalo is again marked by indifference to death; he will preserve Gonzalo because Prospero has reasons for keeping him living.

"If of life you keep a care,
Shake off slumber and beware!"

When the success of his mission is assured, and Gonzalo has been aroused to good purpose, Ariel soliloquizes:

"Prospero, my lord, shall know what I have done:
So, king, go safely on to seek thy son."

The king goes safely, because Antonio and Sebastian have been checkmated by Gonzalo aroused by the spirit.

The sixth scene is that in which Stephano and Caliban discuss affairs of state, and the monster outlines the conspiracy against the life of Prospero. Ariel enters invisible. He speaks four times. His speeches are "Thou liest," "Thou liest, thou canst not," "Thou liest," and "This will I tell my master." There is no evidence in this scene that Ariel is on duty, and his interference, though opportune, appears frolicsome. However this may be, he, either through obedience to Prospero or through affection for him, reports the conspiracy against him. After causing poor Trinculo a beating, he plays the tune of Stephano's catch, and leads the monster and his friends by the music to the "filthy-mantled pool." This is the fourth labor of Ariel, and for it he is highly commended in Act IV by Prospero.

In the seventh scene Ariel, assisted by certain other spirits, over whom Prospero

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gives him authority, presents a magic banquet before the nobles. Just as Alonso and his courtiers are about to "stand to and feed," being fatigued by their wanderings through the island in quest of Ferdinand, Ariel claps his wings upon the table, and the banquet vanishes. Ariel then addresses to Alonso, Sebastian, and Antonio a most solemn and effective speech. He declares them unfit to live.

Enraged by these charges, they endeavor to attack Ariel, who, however, gives new proof that power is at hand to disarm the "three men of sin." He declares even their valor to be wrong and suicidal. He declares spirits to be in league with the elemental fates, implying that through this league an appeal to natural force becomes useless against a spirit. Ariel vividly sets forth the foulness of the banishment of Prospero and Miranda, and concludes his searching lecture by the heaviest judgment, with only a slight hope of escape, dependent upon "heart-sorrow and a clear life ensuing." Ariel vanishes in thunder, and mocking shapes carry out the table.[1] None of Ariel's labors is more lauded by his master than this soul-piercing exhortation. Nothing is less in the true nature of Ariel than this Hebraic denunciation of sin, nothing less in the usual manner of Shakespeare; it is therefore to be observed with proportionate attention as significant and important. It is through this labor that the consciences of the egoists are touched, and, while two of them are scarcely softened, all three are defenseless and stand desperate, and openly condemned for selfishness and injustice.[2]

The masque of the fourth act follows hard upon this scene.

Prospero praises the spirits and calls upon Ariel for a sixth labor. He is to prepare the masque instantly, "With a twink." "Well, I conceive," he replies. As the spirits enter, silence is enjoined and soft music is heard. Ariel presents Ceres, but all the speeches of the masque are bright and spiritual, the sense-objects being chosen to suggest beauty as well as plenty. The question of Ceres concerning the presence of Venus is made the condition of the presence of the goddess of plenty

> "Tell me, heavenly bow,
> If Venus or her son, as thou dost know,
> Do now attend the Queen? Twice they did plot
> The means that dusky Dis my daughter got,
> Her and her blind boy's scandal'd company
> I have foresworn."

Iris replies:

> "Of her society
> Be not afraid; I met her deity
> Cutting the clouds towards Paphos and her son
> Dove-drawn with her."

Ceres, thus pacified, sings promises of plenty. After the masque, Prospero is deeply moved by certain thoughts, but he does not neglect to praise the spirits

[1] This miracle of providing food by magic was in Bacon taking on a scientific significance at this time.
[2] This is a Neo-Hellenic reading of sin as stupid, ugly, and subversive of freedom.

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courteously, if somewhat briefly. He then makes the most profound of human reflections: "We are such stuff as dreams are made on": all that is of the senses fades away, and changes to something rich and strange, and we at the core are spirits such as produce and are our dreams. This reflection, in its disturbing reaction, recalls that incarnation of sense, the beast Caliban, who is as far as possible from his master's ideal. Hence, accordingly, Ariel's next service is the disciplining of the three valorous companions whom he had led to the "filthy-mantled pool."

Prospero commands Ariel to bring a load of glistening apparel[1] with which to keep the minds of the three companions turned away from their true purposes of destroying the books of Prospero, Prospero himself, and Miranda. This plan succeeds in spite of Caliban's superiority to the allurements that overcome fool and butler. Mountain, Silver, Fury, Tyrant are the symbolic names of the hounds by which these ignorant wretches are hunted.

In the fifth act Ariel performs two more services for Prospero. As the scene opens, he reminds his master of his promise of liberty. Prospero is not unmindful of what he has promised. In Ariel's reply to the wizard's question concerning the king and his followers, the description of Gonzalo is such that Ariel himself is almost touched by the contemplation of mortal woe; but Ariel is not human in the sense of mortal. When Prospero sees that Ariel himself has a feeling of their affliction, his austerity is moved, and he makes a speech at once tragic and magnanimous. Ariel is dispatched to free the king and his followers; the worst of whom are now weak and distracted, while the others mourn over them in a common fellowship of misery and "heart-sorrow." Ariel fetches them to the cell of Prospero, where they learn to know their real characters in the vivid words of the magician. After this event Ariel sings his song of freedom, with better reason than Caliban had had after forming his league with the butler and the fool. The simple playfulness of the song is superficially astonishing as the expression of the liberty of a being of such power, knowledge, and ubiquity. After the song, which is a cry of joy, Ariel receives a commission to bring the sailors to the cell of learning. While performing this service he incidentally sets the ship to rights. Ariel now ends his arduous tasks by fetching Caliban and his two companions to Prospero, who rates them soundly and gives them employment. Prospero's last words to Ariel are:

"My Ariel, chick,
That is thy charge."

Alluding to the success of the voyage to Italy:

"then to the elements
Be free, and fare thou well!"

It is clear that the play offers no dearth of facts about Ariel. These facts, too, have the similarities and significant relationships necessary for generalization. During the action Ariel appears as one who is much freer than he has been and much less free

[1] Cf. *Sartor Resartus.*

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than he would be. If not strictly omnipotent, omniscient, and omnipresent, he yet has power to do all, knowledge to answer all, and ubiquity to be where his wise master desires, and Prospero's requirements surpass those of any ordinary mortal. Ariel is not a disembodied spirit, but his body is ethereal, changes its form, renders itself invisible, has attributes and powers not possessed by the ordinary "vesture of decay." Mentally the spirit displays powers of reasoning and remembering; his will is manifest in a persistent desire for freedom. Social opinion, affection, interest, purpose, he has none. He is not, like Caliban in scene ii, below social interests, and content in ignorant solitude; he is rather above social interests, more god than beast. If he cannot feel social interests as those who live among them, he nevertheless sees them and knows all their bearings and relations. What argument can be used with such a spirit to interest him in social affairs? A being who sees in death only a phase of progress, in sorrow only a purification of spirit, in life only the necessary experience of the soul, looks down with infinite calm upon moral affairs as one who had been through all and proved that all temporal affairs are nothing but a useful illusion.

There is only one argument that avails: It is the work of mortals that has set this spirit free; he must repay this debt; if not, an inexorable law enables his liberator to imprison him again. The gods dare not do wrong. And, in spite of his stubborn desire for freedom, Ariel's fine intelligence makes him an obedient, though at first moody, servant of the general weal of the little state.

As a spirit, Ariel is playful and devoted to pure beauty freed from any sense of utility, pure, and averse from the bondage of ignorance and the fatal senses that dominate Caliban. The strongest differentiating feature of Ariel is the note of calm super-mortal joy which seems to say: "I know all that, but everything is quite right; a mortal is a fool who does not understand." There are spirits and spirits, according to Prospero; some spirits being Ariel's "meaner fellows," the rabble, "over whom I give thee power;" all these have superhuman powers. But there is no evidence that Ariel is an absolute or perfectly developed spirit; he is a "chick." This immanent power upon whom Prospero has laid fetters, after freeing him by the exertion of his own learning and sympathy, is the power that Prospero can control: he is not absolute, infinite, final; but merely better than his meaner fellows. To Prospero he is known immediately; to others, rather through his works. His services are: (1) he wrecks the ship, disperses the fleet, conducts the nobles into the island; (2) he leads Ferdinand to Miranda and is the cause of their romantic meeting; (3) he rouses from lethargy that best prop of his state, the honest counselor Gonzalo; (4) he acts as detective and informer for Prospero; (5) he preaches to the "three men of sin" a most convincing sermon, full of power and terror, with just a spice of mercy at the conclusion; (6) he performs a masque illustrative of the blessings following upon a true love marriage; (7) he assists in punishing the citizens of the island who rebel against a just and wise ruler; (8) he conducts the king and his followers to

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their reconciliation with Prospero; (9) he frees the common sailors and leads them to the cell of learning; (10) he frees Caliban, Stephano, and Trinculo, and brings them to the cell where they are treated as well as possible; (11) we may suppose that he gives the good ship which he has restored, and all the other good ships, a fair voyage to port. Such are the eleven labors of this delicate Hercules. But none of these acts as social, altruistic, or primitive, is an act of Ariel. They are manifestations of power and intelligence; their sole purpose is the love of liberty and fear of slavery. What, then, is Ariel? The creative imagination? The mysterious inner spirit of man evolved through culture? The spirit of some great departed poet? These and the multitude of similar question, or forms of the great question, that occur, must be thought at present to be idle, or irrelevant. Let us simply say with the Folio of 1623, or, as one may believe, with the creator of Ariel, Ariel is "an airy spirit" and know him and reckon him in the play, not by some phrase suggesting modern psychology or metaphysics, but by the qualities, language, services, relations, discoverable in the play of which he forms so important a part. He is clearly a contrast to Caliban, and as Caliban is the beast, so Ariel is the angel, though not yet the god. Ariel is the spirit attendant upon Prospero's scientific truth, and his acts are types of the movements of civilization that make for freedom. Dowden's idea that Ariel represents art, though true in a sense, is only a small fraction of the truth. Ariel stands, for all aspects of freedom, the human spirit freed by the truth.

Caliban: Type of Sensualism

Caliban appears in five of the nine scenes: the second, fourth, sixth, eighth, and ninth. The first mention of him is made by Prospero, about fifty lines before Caliban's entrance. Reminding Ariel of the torment from which he had freed him, he recalls Caliban's mother, the foul witch Sycorax. Afterwards Prospero calls Caliban a "poisonous slave, got by the devil himself upon thy wicked dam." Near the end of the play all this is greatly emphasized by being repeated with precision:

> "This mis-shapen knave,—
> His mother was a witch; and one so strong
> That could control the moon, make flows and ebbs,
> And deal in her command without her power.
> These three have robbed me; and this demi-devil—
> For he's a bastard one—had plotted with them
> To take my life."

Prospero tells Miranda that Caliban is necessary to their well-being on the island.[1] Caliban's first words imply his dislike for profitable labor—"There's wood enough within!" He enters uttering curses which are none the less vigorous for being uttered in language learned of Miranda; the diction alone is polite. Caliban's second speech is characterized by Prospero as elaborately false. His third speech

[1] Cf. Emerson's conception of the use of the lower classes.

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admits the charge of brutal and cruel sensuality. Prospero's threats of physical torment reach his imagination and subdue him.

The general impression left by the facts of this scene is that Caliban is a beast. His plea for kind treatment is the cunning of an animal who could not have imagined kindness of himself. Prospero had treated him kindly long enough to find the folly of his policy, and Caliban had learned enough of kindness to reproach Prospero for his necessary harshness. Prospero speaks of Caliban as incapable of improvement; he may be made useful by supporting Prospero, but as Caliban he is a beast. Cursing, sloth, falsehood, sensuality, ingratitude, are strongly indicated. But he is vigorous. Every word speaks of a great primitive reservoir of social power ready to be used in the work of progress as soon as enforced labor and discipline are applied to utilize it.[1] In one short lifetime Caliban cannot be refined for the companionship of "good natures," yet it is admitted that he can learn, and to learn is to transfer some of the vast primitive energies to the brain. And Caliban's language evinces some powers of reasoning, and vivid powers of perceiving, which give a certain beauty to his rhythm and imagery.

In the fourth scene Caliban appears with a load of wood. His speech confirms one's admiration of his vivid perceptive powers, his energy, his great heartiness and interest. He shows equally the diabolical aggressiveness of his father and the shuddering superstition of the hag Sycorax—qualities that appear wholly bad in their brutal primitiveness.

Trinculo finds this beast similar to a fish. Caliban observes Trinculo and Stephano and says but little. At first he takes them for spirits sent by Prospero to torment him; afterwards he worships Stephano as a brave god who bears celestial liquor. Stephano attracts him more, as being more pretentious and self-assertive. Trinculo, a silly easy-going fellow, is mildly jealous of the honors paid to the butler, and there is threatened dissension in the newly formed state. But the bottle proves efficacious and the three depart, Caliban shouting his battle cry of freedom, and leading the way.

The facts offered here indicate unmistakably that Caliban is capable of social development. It is strange to see a fool and a drunken butler succeeding where Prospero had failed; yet it is clear that, while Caliban cannot ascend the ladder to Prospero at a step, he can mount the first rung by the help of a pair of knaves scarcely above him in knowledge, and inferior in power and integrity of instinct.[2] Caliban's education requires him to know him on his own level in order to know himself; to become worse in order to become better; and in this he suggests the general truth that without the division of the elemental forces there can be no refinement and no progress. Caliban's love of nature is genuine, but sensual. The "clustering filberts" please him because they are easy to gather and good to eat; this love of nature is

[1] This and other parts of the play irresistibly recall Plato, Dante, Spenser, and all the great philosophic poets. Cf. Homer's Thersites.

[2] Cf. the value of even the lowest political bosses in arousing some, though at first an evil, interest in politics among the lowest classes. Cf. also Salvation Army methods.

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very far from the desire to live merrily "under the blossom that hangs on the bow;" where the pleasure of Ariel depends less even on the sense-harmony of this perfection of natural loveliness than upon its imaginative value as the illusion representing all harmony.

In the sixth scene Caliban is fairly launched as the citizen of a commonwealth less ideal than Gonzalo's. His knowledge of affairs proceeds apace under the instruction of the self-assertive Stephano and the foolish Trinculo, burlesque shadows of the selfishness and weakness of the great convention that produced them, as their ideal state is a bold burlesque of all states.

Caliban drinks freely and is servile to excess; he takes sides in politics, becomes a courtier, and has a suit at court. He succeeds in gaining a victory over Trinculo, who is beaten for a prank of Ariel's, who enters when Prospero's interests are threatened. Caliban's plot against Prospero shows some capacity and clear instinctive judgment, especially when he dwells upon the danger to ignorance to be feared from the books. There is a reckless humor about this conspiracy which makes it seem unreal and less horible than that of Antonio and Sebastian against Alonso and Gonzalo. This arises from the stupidity of the conspirators, whose passions are, however, none the less capable of producing the worst results. The interruption of the conspiracy by Ariel's music draws from Caliban a speech which makes a new important fact in generalizing his character. In sleep he has visions in which the sensual appetites are dormant, and he dreams of heavenly riches; and the music of the island is a harmony capable of soothing and composing his passions. They go out this time together to follow the music which, like the lute of Orpheus, leads all that hear.[1]

The facts of this scene first confirm all our bad impressions of Caliban, and then complicate the character by indicating clearly that he has some susceptibility to influences not connected with the sensual appetites, but with the æsthetic sense; that, in a word, he has moods in which he vaguely feels that the faculty of æsthetic dreaming is more blessed than to eat and to drink.

After the masque in the eighth scene Prospero calls Ariel and says, "we must prepare to meet with Caliban." Ariel speaks of the power of music over the three drunkards, comparing them in this to colts. Caliban and his friends are both urged by their own evil purposes and the celestial liquor, and drawn by the music of the spirit on their course to the pond. The end of it is that they stand saturated in filth up to their chins. Prospero fears Caliban grows worse as he grows older.

Just as the three conspirators with bloody thought approach, they are caught by the sight of rich garments set by Prospero and Ariel "for stale to catch these thieves." While the butler and the fool are enjoying the playing with the rich garments, Caliban is disgusted and urges prompt action. But Prospero and Ariel now hunt them with spirits made visible as hounds who torment them.

In this scene Caliban appears to advantage as scorning the trumpery garments

[1] This love of beauty is the seed of conscience in Caliban, and is the most audacious stroke of insight in the play.

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which prove too alluring for his friends. But he suffers with them for keeping bad company. In the last scene Prospero commands Ariel to set Caliban and his companions free. Caliban, upon seeing Prospero and the strange lords, admires them, and believes them spirits. He fears punishment.

Prospero describes Caliban's origin, but ends by saying: "This thing of darkness I acknowledge mine." Caliban fears greatly. Alonso, pointing to Caliban, says: "This is as strange a thing as e'er I looked on;" to which Prospero replies: "He is as disproportioned in his manners as in his shape," and orders Caliban to his cell to work. There is no possible salvation for Caliban but in work; and even in this ideal time of general joy, power, and forgiveness, Caliban must be made to work, which he would never do of his own free will.

But Caliban's last speech is one of the most extraordinary facts to be weighed in connection with this wonderful monster.

Prospero says:

> "Go, sirrah, to my cell:
> Take with you your companions: as you look
> To have my pardon, trim it handsomely."

Caliban is very much afraid of punishment. But in earlier differences with his master no fear had checked his curses and vile wishes. Caliban has now seen the world for himself; by comparison and solid thinking, founded on his observations, he has discovered the superiority of Prospero. It is certain that the sullen momentum of Caliban will go far to carry him toward any purpose he forms. What he says is:

> "Ay, that I will; and I'll be wise hereafter,
> And seek for grace. What a thrice-double ass
> Was I, to take this drunkard for a god,
> And worship this dull fool!"

Caliban is the beast; as Antonio is a fiend, and Gonzalo a saint, so Caliban is a beast. But, though animality, sensuality, and all beastliness riot in this great mass of muscles, bones, and blood; though his senses report facts in the most vivid and savage manner; though his powers of generalizing are low and stupid, he, like the toad, ugly and venomous, bears yet a precious jewel in his head. And we can form some conception of the means by which experience will bring some wisdom and grace, until the animal energy is further converted into thought.

Prospero: the Scientific Type

Prospero appears in the second, fifth, seventh, eighth, and ninth scenes. His first words in scene ii are:

> "Be collected:
> No more amazement; tell your piteous heart
> There's no harm done."

Miranda's sympathy is deeply stirred by the vessel in the tempest, and she replies:

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"O, woe the day!" "No harm," repeats Prospero, "I have done nothing but in care of thee." In this we see the motive of the tempest: Prospero has caused it solely in the interest of his daughter, who is the rightful heir of Milan. He throws aside the magic garment which is necessary to his control of the spirit, and proceeds to narrate in simple paternal manner the history of his life, so far as Miranda needs to know it, in order to understand why her father has been seemingly cruel.[1]

He calls upon Miranda to look searchingly into "the dark backward and abysm of time" in origin to bring back her origin. She has only the vaguest remembrance. Prospero presents the facts. Prospero had been duke of a state without a parallel for the liberal arts—meaning presumably, the arts of war and peace, science, philosophy, literature, sculpture, architecture, mathematics, and other branches of study. Prospero emphasizes the superiority of his signiory; it was the first, and Prospero the prime duke. This is important, inasmuch as it makes his downfall more striking. Here follows a long and exceedingly strong description of the ambition, treachery, and success of the usurping Antonio. Alonso is described as an inveterate enemy of the student Prospero. Antonio becomes a tributary of this king in order to procure his assistance in supplanting his brother. The story is told with intense vigor, every sentence full of indignation and of the emphasis of one who has brooded over his wrongs.[2]

> "In few, they hurried us aboard a bark,
> Bore us some leagues to sea; where they prepared
> A rotten carcass of a boat, not rigged,
> Nor tackle, sail, nor mast; the very rats
> Instinctively have quit it."

The goodness of Gonzalo is spoken of as a manifestation of Providence divine. Food, fresh water, rich garments, linens, stuffs, and necessaries, and volumes from his own library, prized above his dukedom, were the means of his preservation, and of the after-progress of his finally successful researches.[3]

Prospero has spent his leisure in study; love of learning was the cause of his banishment, and, though he feels his brother's treachery, he has been happy with his books and the education of Miranda.

Prospero, about to speak of the present and to summon Ariel, resumes his magic robe.

Fortune, formerly his enemy, is now in league with him, and he seizes his opportunity to assert his rights and regain his dukedom, lost for twelve years.

He suggests sleep to Miranda, tells her it is a good dulness, and to give it way. Miranda, in spite of the exciting revelation she has listened to, falls asleep.

[1] This garment indicates his purely philosophical point of view: without it he plays a simple rôle among other mortals, and with like passions.

[2] A story as old as that of Cain and Abel.

[3] If there were any "allegory" or "enigma" in the play, this might suggest the renascence of the Hellenic spirit in Shakespeare's age.

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Prospero receives from Ariel the report of the shipwreck, and of his disposal of the voyagers. Finding Ariel moody, he speaks harshly to him, reminding him of his slavery to Sycorax, of his torture in the tree, and of his own kindness in freeing him. He threatens him with worse torture, promises him his liberty, and succeeds in asserting his authority satisfactorily.

Ariel departs, Miranda awakes, or rather is roused by the magician. The father and daughter visit Caliban. Caliban is also rebellious and anxious to regain his liberty. Prospero treats him most harshly and successfully asserts his control.

When Ariel leads in Ferdinand, enchanted by his songs, Prospero meets them with Miranda, and takes the deepest satisfaction upon seeing that the meeting results in love at first sight. It is made clear that one of Prospero's chief purposes in causing the wreck was to bring about this result. From the romantic point of view, all is going satisfactorily. But romance must be guided by wisdom. Ferdinand is treated with a great show of harshness, for Prospero holds that too light winning makes the prize light, and takes care that the course of true love shall not run smooth. Ferdinand is made to feel the authority of Prospero, and is set at a heavy task of bearing logs.

This scene contains a large number of facts concerning the life and character of Prospero. First we learn that by right he is a powerful duke, but that through love of learning he has lost his practical interest in, and hold upon, affairs; that the vigilant ambition of his brother has seized the opportunity this offered to usurp his power; and that Prospero's studies having fully succeeded, and more than restored the power they had robbed him of, he will now, fortune being favorable, proceed to reassert his right to rule and depose the usurper; his plan extends not only to the reconquest of Milan, but, through an alliance with Ferdinand and the imprisonment of Alonso, to the inheritance of the larger world of Naples. Prospero's life falls into three parts: the past, in which he ruled successfully, just and beloved by his subjects; the present, in which he is banished and his rule is divided among selfish egoists, held in check by the mild Gonzalo; the future when Prospero shall rule again with justice, vigor, and the knowledge that is power.[1]

Prospero, through the knowledge derived from the books saved from his ancient library and derived from his own researches, raises a storm which brings the "three men of sin" within his power. But his motive is not revenge; he desires to secure the rights of his daughter, in whom all his hopes of the future are centered. Her learning and characte. are a guarantee that the state unparalleled for the liberal arts will continue to be great and renowned.

Prospero is one who has risked all in the pursuit of true knowledge, and, having lost all, is about to win back more than he had lost, after having acquired all the power that knowledge can give.[2]

[1] The Greek idea of the philosopher as king.

[2] Cf. Bacon's favorite theme of knowledge as control.

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Prospero has had the most intimate and vital relations with the four characters already studied. Antonio, the selfish conspirator, is his brother, but his greatest enemy. Gonzalo has been his true preserver. Ariel is his powerful messenger, Caliban is his wicked but useful slave. *He holds a central position with reference to these four persons, who in their relations to each other are strongly contrasted pairs.*[1]

Prospero is not a magnetic character; his austerity and love of authority are not attractive. In this scene his whole relation to Ariel, Caliban, and Ferdinand is that of a harsh task-master; there is a certain crudeness about the monotony of his injunctions to work, and the work assigned the lover is the same as that assigned to Caliban, the carrying of logs. Prospero is wise, just, not more solicitous for himself than for the true interests of all the others; but outwardly at least he is too faultless, unsympathetic, regulated by high purposes, to be attractive through his personal qualities. Even his command of magic has something in it which appeals to none of the customary dramatic interests.

But there are glimpses of a different Prospero at times; and an occasional effusion of feeling for Miranda, Ariel, or Gonzalo reveals the tenderness and sensibility controlled by Prospero's wisdom, and suggests the Hamlet-like refinement and sweetness which had caused his downfall, and of which he had learned to make stronger use. He is a learned, just, and loving man of brooding thought, profound melancholy, and extreme sensibility, endowed with boundless power.

In the fifth scene Prospero appears behind Miranda in her stolen visit to the scene of Ferdinand's labors. He speaks three times. His words are:

> [*Aside*] "Poor worm! thou art infected
> This visitation shows it."

> "Fair encounter
> Of two most rare affections! Heavens rain grace
> On that which breeds between them!"

And in conclusion:

> "So glad of this as they, I cannot be
> Who are surprised withal; but my rejoicing
> At nothing can be more. I'll to my book;
> For yet, ere supper time, must I perform
> Much business appertaining."

He is controlling human life. The absence of the romantic element in learning may blind criticism to the significance of this speech. It is the most emphatic speech of Shakespeare's wisest character. "My rejoicing at nothing can be more." The romantic interest is kept central and uppermost by this speech. The learning of the reader finds much to elaborate in *The Tempest*, but until the love story is loyally recognized as the true interest there can be no grasp of the play in its simple greatness. All proportion in this romantic drama depends upon the recognition of

[1] There is a chilling symmetry in the character-contrasts.

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the love-story as the beginning, middle, and end of the whole action. Prospero's greatness must be seen by the wise and learned, not as less than they had supposed, but as being far inferior in importance to the love of Ferdinand and Miranda; Prospero, with all his magic and dignity, is merely the heroine's father, and a rather interfering old gentleman at that. One may peer through learned spectacles for the appearance of the scientific Prospero upon the stage, but the true "understander" must look more eagerly still for the lovers. This or nothing is the poetical philosophy. Hence Prospero says:

"So glad of this as they, I cannot be,
Who are surprised withal; but my rejoicing
At nothing can be more."

In this we see that Prospero is not merely a duke, magician, scholar, but a man—one who carries all the interests of life in their full weight, but regards them all as subordinate to true love of the pure romantic type. It is this more than anything else that identifies Prospero's point of view with that of the mature Shakespeare. And it is this that should make one reflect when Prospero says:

"My rejoicing
At nothing can be more."

All his hopes center in this alliance which will give Naples to Miranda and Miranda to Naples. Every incident narrated in the play is directly associated with this love-story. Learning, morality, philosophy, may interpret the incidents profoundly; but romance alone interprets without distortion or disproportion, and a pair of lovers cast contempt upon the pride of learning and magic. The quiet humor of Prospero in this scene is full of sympathy and pure affection.

Moralists have found a solemn warning for lovers in the fate of Romeo and Juliet. "Violent delights have violent ends," is the favorite text, chosen from the speech of the moralist of the tragedy, Friar Laurence. Prospero seems to tell us in this scene that Romeo and Juliet are perfectly ideal, but they need wisdom to guide them and watch over them, not the nurse and the Capulets. Shakespeare may quarrel with the environment, but never with love; the moralist blames the lovers, and quotes the good Friar Laurence.

In the seventh scene Prospero is present, but invisible to the king and his followers. In an aside he declares that some of the lords, meaning chiefly Antonio and Sebastian, presumably, are worse than devils. "Devil" is the term applicable to the father of Caliban, whence Caliban is called a "demi-devil." At the end of the banquet scene Prospero praises the spirits, declares his plans are progressing favorably, and returns to visit "Young Ferdinand" "and his and mine loved darling."

Prospero's relation to his enemies is not one of weak and effusive forgiveness, but of strong subjugation, judgment, and forgiveness equal to their capacity for appreciating forgiveness.

In scene viii Prospero begins to throw off his harshness because he is perfectly

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assured that all will go as wisdom requires. Ferdinand's work and patience enable Prospero to show how kindly he has regarded him. The important thing about the masque is that it is bestowed upon the eyes of this young couple as a reward of their purity and devotion, and that even to tediousness Ferdinand is lectured on his abstemiousness up to the very moment when the preparations cease and the masque begins. The content of the masque echoes this introduction, all the blessings promised being conditional upon the temperance and goodness of the lovers, and the absence of Venus and her son.

The masque ends abruptly. Prospero starts suddenly at sight of the Reapers and Nymphs dancing; after which, to a strange, hollow, and confused noise, they heavily vanish. What has disturbed the magician while Ariel is executing the dream of an ideal republic sanctioned and ratified by Ceres and Juno, and brimming with beauty, plenty, hope, power, and purity? "I had forgot that foul conspiracy of the beast Caliban."

Thereupon follows the dismissal of the merry actors. Our revels now are ended. The actors were spirits and are melted into thin air. While the actors are mortal and sensual, the drama of life may be beautiful in part, but at the worst it ends in heaviness and confusion. The *summum pulchrum* rests in the spiritual state. All that is of sense must dissolve. What, then, remains is the real self. "We are such stuff as dreams are made on." The ideal commonwealth is not within "the most precious square of sense;" not in the world of Antonio, Caliban, and Gonzalo, but in the world of Ariel, of spirit-life. "Troubled I am." This is the manner of Theseus about to wage war against Creon. *Wisdom can find the way* to the ideal world, but the mortal brain is troubled, and the scholar feels that the pageant of life must be renounced in its entirety; Milan, Naples, books and all, are transitory—an illusion; "I am sufficient to tell the world, 'tis but a gaudy shadow, that old Time, as he passes by, takes with him." Prospero leaves the insubstantial pageant to return to the most disagreeable of his duties, the disciplining of "a devil, a born devil." The scene, which opened so brightly, ends with an air of sadness, if not of fatigue; but with the customary austerity of Prospero:

> "Shortly shall all my labors end, and thou
> Shalt have the air at freedom: for a little,
> Follow, and do me service."

This is the absolute renunciation of mortality. In the spiritual state alone is immortality and liberty. Wisdom may bring beauty, purity, peace, and plenty, but not undisturbed by ignorance and the limitations of sense. A comparatively ideal commonwealth is possible even to mortals, but the *summum pulchrum* rests in dreamland.

The emotion of the latter part of Act IV is a profound indication of the truth that the absolute serenity that philosophy desires is beyond its reach. While it seems to mar the dignity of Prospero, it restores him to the social relations and makes it possible to sympathize with his austere and unattractive exterior. Perhaps it may be thought a culmination of tragic sublimity.

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The fifth act is full of Prospero's words and influence. Hamlet once said: "The time is out of joint." Prospero is in strong hope: "My spirits obey, and time goes upright with his carriage." It is as if Hamlet had followed his impulse of returning to Wittenberg, and had through learning acquired the power to overcome his wrongs and seize his birthright, laying the tortured ghost by raising the spirits.

Ariel's report regarding the prisoners moves compassion in the justly indignant Prospero. "The rarer action is in virtue than in vengeance." He has Antonio completely at his mercy; it is because of his nobler reason that, though struck to the quick with the vile treatment he has undergone at his hands, he conceives it not worthy of himself to destroy him. Having decided upon a course of clemency, he dispatches Ariel for the prisoners. Prospero makes a speech concerning his magic art. The greater part of it consists of an apostrophe to the various spirits controlled by his art; he speaks in high praise of the potency of his knowledge—"graves at my command have waked their sleepers, op'd and let them forth." His powerful yet rough magic must give way to music. All the services of Ariel have been directed to the ends of justice, peace, harmony, and fraternity; now that these are about to prevail no services will be required of him; music will take the place of Prospero's potent but rougher art, and harmony will ensue. Staff and book will give way to heavenly harmony. Solemn music is called for to produce a healthy and reasonable rhythm in the brains of the king and his followers, now boiled within their skulls; the charm dissolves; the morning steals upon the night; their rising senses begin to chase the ignorant fumes that mantle their clearer reason; their understanding begins to swell, and the approaching tide will shortly fill the reasonable shores that now lie foul and muddy. Such is the magic method of this strange magician—so suggestive of modern ideas that it has tempted critics to read later-day science into it. He has brought them to a certain stage of reason by motives of fear, terror, sympathy, and other powerful tragic emotions, and now, finding them listless and confused he completes their cure by a musical charm mingled with suitable words of praise, invective, reproach, forgiveness—all delivered with great energy and conviction.

Prospero desires the common sailors fetched to the cell. Ariel departs, and Prospero reveals himself to the recovering lords in his true character as banished Duke of Milan. His manner to Alonso is more than human in its magnanimity and courtesy:

> "I embrace thy body;
> And to thee and thy company I bid
> A hearty welcome."

There are degrees in forgiveness, and in this scene one finds a compendium of social truth; this estimate of the largest types of social character is central, human, just, absolute—from the poetic point of view.

The praise of patience as the great virtue of the just is an essential part of this

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philosophy. Prospero begins to tell the story of himself and Miranda, but checks himself:

"No more yet of this,
For 'tis a chronicle of day by day,
Not a relation for a breakfast nor
Befitting this first meeting."

Having said merely what is necessary to the introduction of the son whom the king has deplored so sincerely, and the daughter of Prospero whom the world had supposed certainly lost, he shows them the lover playing at chess within the cell. The happy scene that follows is simple almost to commonplaceness, and sublime through its typical breadth.

And is this the conclusion of the learning and magic of Prospero—to bring about a happy wedding like any ordinary comedy? Is there no deeper meaning, no worthier end, after all the complicated tragedy requiring the services of spirits and the most unheard-of learning and power to set things to rights? Such is the simplicity of the poetic point of view that from it there can be no deeper meaning and no more significant conclusion. Alonso echoes the commonplace judgment admirably:

"This is as strange a maze as e'er men trod;
And there is in this business more than nature
Was ever conduct of; some oracle
Must rectify our knowledge."

Prospero is vigilant and practical to the end, showing himself friendly to the honest sailors and severe with the irresponsible delinquents, and yet as kind as true farsighted kindness permits in the balanced interests of the whole society and of each member of it.

How may the facts concerning Prospero be generalized? Prospero is friendly to Gonzalo, whom he calls his true preserver. Yet Gonzalo is a weak character when compared with Prospero; he has Prospero's kind, gentle, forgiving nature, but not his aggressive strength in championing what he thinks right. Gonzalo is immensely and positively good, but his lack of power disables him to such a degree that he is able only to conciliate, placate, remedy evils already done, and quite unable to control powers and events; he renders justice possible, but cannot make it prevail. Prospero will do no wrong and take none.

Prospero tells Ariel that he loves him dearly. But Ariel is playful, purposeless in any social sense, far beyond and in advance of the order of the day. When all are just and ideal, Ariel will be in his element, but he is not of himself able to feel the needs of the little republic.

Prospero is hostile to Antonio. Even while forgiving him he expresses the bitterest contempt for his character. Prospero has all the brilliant reason and splendid energy of Antonio; but vitally fused with these powers in Prospero is the loving kind-

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ness of Gonzalo. In Prospero selfishness is realized in the working for the common good; Antonio is selfish in the unsocial sense.

Prospero is hostile to Caliban. Caliban's morality is not of the cold selfish type; it is backward morality. He is a devil, a born devil, but he is full of possibilities. Prospero's regret is that the problem of inducing Caliban to seek for grace seems insoluble.

Prospero knows these types thoroughly and has them potentially in himself; he knows himself and them by reading, experience, and reflection, as well as by natural breadth, power, and sensibility. He knows life in its conventional sense from Milan, and he knows nature equally well. He is able to teach every character in turn to know himself deeply, truly, and feelingly. He controls, with equal authority Caliban, Ferdinand, and Ariel. He is adored and obeyed by Miranda. He eventually commands the respect of his bitterest enemies, and even Caliban comes to render him a rather hearty obedience. All these relations are made possible through his insight, knowledge, fair-minded bearing, and great feeling. It is easy to say that Prospero is wise, that he is a magician; but what is the nature of his magic wisdom?

That about which Prospero is wise and over which he exerts magical power is life. He is wise in his knowledge of the elements of social life. He is the complete master of the social forces, both as they occur in himself, in his complete, all-round, intensely human, individuality; and also, consequently, as they occur in the society around him, which he identifies with himself, treats as himself, reflects in himself. He is thus the embodiment of the balance of the social forces, an epitome of the selfish and unselfish, sensual and spiritual, shy and aggressive, conventional and natural, romantic and practical types of the race; and because of this, we may suppose, he is at heart under his grave exterior, exceedingly attached to the philosophy of the poet and the dreamer of dreams, expressing his beliefs, not in words, but in things, not in abstractions, but in lifelike illusions; writing, not with ink, but with men and women; and believing and knowing more than philosophy can seriously consider both of the world that is, and of the coming race. His is the science of *controlling* the forces of social life, and its focus is in controlling youth and marriage.

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TENDENCIES IN MODERN MUSICAL COMPOSITION

By George M. Chadwick

The relation of the past and present in music, the tendencies in modern music as they point toward the future of music, are subjects as difficult to understand and define as to foretell the future of poetry by tracing it back to the *Iliad* and then accepting Macaulay's view that "as civilization advances, poetry almost necessarily declines." It would be interesting to trace upon the chart of history those social and political conditions wherein poetry and music were the spontaneous expression of individual and national feeling. However different the medium of expression, there is this in common between poetry and music, that each not only reveals the mood of the age in which it is produced, it also reacts upon that mood; and hence, if we are rightly to judge the tendencies in modern music, we must understand the mood of the present, and ask and answer as best we can: Is this reactive force that of great genius or merely of exceptional talent? The question of the relative merits of genius can be discussed with perfect safety, because all have a right to an opinion and, according to some popular views on liberty, each one's opinion is as good as any other's. But the subject of the mood or conditions of the day must be approached with great caution, for there is so much that is out of tune with art in an age when great value is placed upon phenomena addressed to the physical eye, and the opinions of the majority are more respected than those of the wiser and sadder minority. Not materialism, but rather that mood which encourages and respects materialism, is the crushing force against which man's finer nature is powerless to contend. The creative genius will ever be both independent of and yet dependent on the mood of his time: Independent, in that he is isolated and in a sense unconscious of those demands which most men recognize; dependent, so far as he is dictated by the demands of the public, and in a yet more vital sense by the effect on him of those influences which either tend to encourage or else almost utterly to destroy his creative activity.

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In a general way it can be determined whence and whither came and went this or that period in literature, but the different historical phases of art, especially music, are less easily identified with those larger social conditions to which literature owes so much. Not only this, but the so-called meaning of music is a subjective phenomenon quite independent of outward events.

Historically, it is almost impossible to criticise music except from the standpoint of the present, for at different times the same music has produced different effects. The subject of form can be somewhat definitely considered, but in its truest sense form is innate and not an outward application of rules. It is this latter view of form which ought to be discouraged, as it tends to substitute the study of the letter for the spirit of music. It is nobler to play a Bach fugue than to learnedly talk about it. The desire to analyze and reduce to facts, tends to produce insensitiveness in the realm of the imaginative, resulting in this, that the artistic nature is crushed and superficial learning is recognized in place of the finer artistic feeling which alone is able to create and interpret art. Art begins where definition ceases, and genius silently works unheedful of the theories and so-called learned opinions on the subject of what music has been, is and ought to be.

If we are to be just in this matter we must study the attitude of the composer toward his art and the public, and also thoughtfully view those present conditions which so strongly influence composers. Is that attitude serious, is it sincere? Granting that it is usually both serious and sincere, yet it may not always be right, owing to reasons for which the composer himself cannot be blamed. A less godlike genius than a Beethoven must be swept along by the current of his time. Neither diplomacy nor charlatanism can be forgiven in the world of creative art, but mistakes, the result of misdirected but earnest effort, can be in a measure overlooked. The modern composer has temptations that did not exist in the same sense in the classical period of the eighteenth and early part of the nineteenth century. The tendency of the classic was upward, while that of the romantic is toward the decadent, and hence the romantic can only be preserved by the force of exceptional creative genius. Such a genius was Schumann. "Attitude" is the word so little comprehended and yet so

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vital. The attitude of a lesser composer of the classic period must necessarily have been right. If he failed it was no contradiction to the principles of his art; but the romanticist has the dangerous privilege of being looked upon as not understood, as having penetrated the mystery of life either beyond the power of his art to express, or else as having attained to a statement in his art beyond the power of the world at large to comprehend; and this constitutes a most powerful and at the same time most dangerous factor influencing modern composition.

Someone has said: "There are words that have been in love with each other from the beginning of language, and when they meet, that is poetry." Another has added to these lines: "There are notes in the realm of harmony which are seeking their complement; when found, that is music." Music from Bach to Schumann was in its inner nature lyric. It was the song of the heart, and true music will ever be the song of the heart whether as the simple folk song or as the outpouring of a world of musical feeling in the symphony. The final test, as in poetry, is that music be inevitable. The folk songs of the people have endured through the centuries: the compositions of many a profound theorist of the past, marvels of technical skill and learning, are now almost forgotten. Living as we do in the present age we cannot pass final judgment upon it; but is it not possible to say at least this, that much, very much of modern composition lacks the inevitable? Is it not too often the product of musical scholarship rather than the inspiration of genius? It is impossible to measure these vast tidal waves of art which have swept over the centuries. Their ebb and flow is all-powerful and can be neither hastened nor retarded. Kant confessed that he was overwhelmed with awe by two things: one, the star deep of space, without limit, and without end; and the other, right and wrong. And so he to whom the deeper meaning of art has been revealed, has learned that greatest of lessons—humility in the presence of the unknowable.

Let us now take a more definite view of the several forms as treated by modern composers. In modern songs we meet with much that is uninspired. A glance at the history of song reveals in Schubert that wonderful union of music and words, and if at times his heaven-born music lifts to a higher plane poems in themselves commonplace, it only proves that in

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song it is the music and not the words that gives the stamp of greatness to the composition. With Schumann, Robert Franz, and Brahms, though we feel in the presence of less godlike genius, we also feel that a truer literary instinct guided the composer in a more careful selection of texts. Many a song-writer of today has been influenced for good by these composers; nevertheless a study of modern songs warrants this criticism, that too often the pure lyric note is lacking, and as a result there are composers whose songs suggest miniature symphonic poems with incidental words. There are certain laws which cannot be ignored, and one is that a song must, so to speak, sing itself, and for this reason no form of music takes more speedy revenge on the composer who refuses to recognize its demands.

While the piano and organ have suffered more or less at the hands of modern experimenters, the danger has been less, because those pianists and organists worthy of being called artists, are too well acquainted with the inexhaustible literature bequeathed by the masters for these instruments to be easily led astray.

To worthily speak of the modern opera, or music drama, would require a separate paper, involving us in a discussion of Wagner, his theories relative to the music of the future, and the effect of his composition and theories on the composers of today. On a gigantic scale his works illustrate the influence of the literary attitude toward music, and he has unquestionably come nearer to a true statement of the matter than any other modern composer, for he was consistent in his attitude and remained true to his high ideals, sweeping all obstacles aside by the tremendous force of his creative musical genius.

It is in purely instrumental music rather than in the lyric drama that the violation of the scientific principles of musical æsthetics is most dangerous to music. Realism in instrumental music—that is, the use of a text or "programme," the attempt to describe literally a mood, a scene, or even an entire poem or the life of a hero—is often commendable, not only as a guide to the mood of the composer, but also as a means of assisting the imagination of the hearer. A privilege allowed a great composer, in lesser genius is too often a temptation leading to disastrous results. It would be interesting, did space allow, to cite instances of this realism in the works of

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the older masters; but it is necessary to limit this observation to the relation of realism to modern composition, with a reference to its abuse. What may be termed the literary tendency encourages and at the same time disguises this abuse: the tendency to place pseudo-musical experiments in tone (mere results of study and ingenious device) above their actual musical value, not infrequently leads to an almost patronizing attitude toward the compositions of Mozart and Schubert; an attitude due to the failure to understand the immense distance between genius and mere talent and also an overestimation of the importance of mere technical achievement. Oliver Cromwell said: "A man never rises so high as when he knows not whither he is going." Genius works silently, guided by an intuitive force rather than by theories. The critical writings and theories of poets, painters, and composers are, after all, incidental to their creative energy. Hence, if art is really great, if art is the ultimate expression of the sensitized human consciousness as opposed to the insensitive, the coarse and brutal, then are we compelled to respect this intuitive power of genius as the truest, most real phenomenon, and question any attempt of science or theory to divert it from its natural course.

It is claimed in defense of modern originality that it was ever thus, genius having always struggled against precedent and pedantry. But what is true of the past is not necessarily true of the present, removed as it is to a sufficient distance rightly to behold those mountain peaks of genius—heights which could not be comprehended by the observer standing near them, whose vision might easily have been intercepted by mere foothills which are lost to view at this distance. It is impossible to anticipate judgments self-infolded in the future. Though the contending opinions of modern conservatives and radicals in music cannot be reconciled on neutral ground, it is possible in a measure to understand the attitude of those widely differing in opinions. To conservatives (now alas, too few) educated as a rule amid the great Leipzig influences of Germany, the works of the classic period are a known truth in a sense possibly not understood by a younger generation molded under different influences. It is doubtless true that this is not because the former understand the modern spirit less than the younger enthusiasts who dream of "impossible destinies" in music, but that they (the conserva-

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tives) alone truly understand the past. Nor is this opinion a mere theory: its truth is established by no less authority than the attitude of some of the greatest of modern composers. Wagner, that commanding force in the revolutionary spirit of modern music, worshiped Beethoven as a god, refusing to write a symphony because Beethoven had written the last great symphony. Only recently it is said of one of the greatest modern composers that after conducting Beethoven's Ninth Symphony, he turned with tears in his eyes to one standing near and exclaimed: "If I could only compose such music!"

While it is true that no one claims that the creative power of the present is as wonderful as that of the past, it is also true that an understanding of what constituted the real greatness of the past is far from being generally understood. The musical world today is intoxicated with technique—the technique of soloists, of orchestras and of composers. It is indeed truly wonderful to what heights virtuosity has reached, but alas, it is the universal history of art that the beginning of its ultimate decline is marked by the worship of technique. The gravest danger seems unquestionably to be that the virtuoso technique in orchestral composition is demanded of the modern composer. It is difficult to conceal poverty of musical ideas on the keyboard of the piano, but in the orchestra it is far different, and especially in the modern orchestra with its unlimited resources in tone—color and technical possibilities. The impressionist in music can give to the world impressions, moods stated in gorgeous masses of tone-color, and by "wandering through all the known and unknown keys," overwhelm a listening public, unable as it is to contradict such a composer's methods.

C. Hubert H. Parry, in his valuable work on *The Art of Music*, has most clearly stated this relation of the modern orchestral composer to the public in the following criticism on Berlioz, who so strongly influenced modern orchestration by his compositions and theories. "The kernel of the Gallic view of things is, moreover, persistently theatrical, and all the music in which they have been successful has had either direct or secondary connection with the stage. Berlioz was so typical a Frenchman in this respect that he could hardly see even the events of his own life as they actually were; but generally in the light of a sort of fevered frenzy, which

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made everything—both ups and downs—look several times larger than the reality. . . . His enormous skill and mastery of resource, brilliant intelligence, and fiery energy were all concentrated in the endeavor to make people see in their minds the histrionic presentation of such fit histrionic subjects as dances of sylphs, processions of pilgrims, and orgies of brigands. Even the colossal dimensions of his orchestra, with its many square yards of drum surface, with its crowds of shining yellow brass instruments, is mainly the product of his insatiable theatrical thirst. It imposes upon the composer himself as much as it imposes upon his audience, by looking so very big and bristling to the imagination. But, though it makes a great noise, and works on the raw impressionable side of human creatures, and excites them to an abnormal degree, the effect it produces is not really so imposing as that of things which make much less show—for instance, the opening of Beethoven's B flat Symphony, which requires only seven different instruments to play it, and is all pianissimo. The means are in excess of the requirements; or rather, what should be means become requirements, because the effect is made by the actual sound of the instruments, and often not all by the music they are the means of expressing. And this aspect of Berlioz's work is even more noteworthy in relation to modern musical development than the fact that he uniformly adopted a programme for his instrumental works. He was a man of unusually excitable sensibility, and the tone of instruments, like color, appealed to him more than any other feature in music. He was also a man of literary tastes, and had no inconsiderable gifts in that line, and was more excited by the notion of what music might be brought to express than by the music itself."

The above is a most admirable statement of modern tendencies in orchestral composition, and it is no reflection on the few great living orchestral composers to say that it is now possible for a composer to claim as originality what is in reality the opposite, because the world today is looking for startling, heretofore undreamed of orchestral effects; and every composer who desires recognition must strive to rival his colleagues in the virtuoso style of orchestral composition, knowing that a beautiful musical thought simply stated would be looked upon either as stolen from the masters of the past or as a confession of an inability to write in a

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worthy (?) manner for the modern orchestra. A calm unprejudiced observer may safely say that this is a transition period, or possibly a preparatory one for some future Beethoven. A Beethoven may never again appear, but if he does he will settle in his own way the problem either by denouncing the modern attitude toward orchestral technique, or else, which is more probable, by making that technique subservient to higher ends, he will prove that music must be judged by its thematic material and the harmonic and contrapuntal development of these themes. Of only one thing can we be certain, and that is that such an one will be no experimenter, that he will have a divine message in music not dependent on this wonderful medium of expression, but made more glorious by reason of it.

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A DEFINITION OF QUATERNIONS BY INDEPENDENT POSTULATES[1]

By Miss Ruby L. Carstens

§ 1. Quaternions with respect to a Domain D[2]

The usual theory relates to quaternions $a_1+a_2i+a_3j+a_4k$ in which the coefficients a_i range independently over all real numbers or else over all complex numbers, and the units have the following multiplication table:

	1	i	j	k
1	1	i	j	k
i	i	-1	k	$-j$
j	j	$-k$	-1	i
k	k	j	$-i$	-1

These give the real quaternion system and the octonian system.[3] As an obvious generalization, the coefficients may range independently over all the elements of any domain D.

§ 2. The Postulates

A set of four ordered elements $a=[a_1, a_2, a_3, a_4]$ of D will be called a quaternion a. The symbol $a=[a_1, a_2, a_3, a_4]$ employed is purely positional, without functional connotation. Its definition implies that $a=b$ if, and only if, $a_1=b_1$, $a_2=b_2$, $a_3=b_3$, $a_4=b_4$.

We make the following five postulates concerning quaternions in connection with the elements $0, +1, -1$ (γ_{ijk}) which are used 4^3 times as follows:

$$\gamma_{111}=\gamma_{122}=\gamma_{133}=\gamma_{144}=\gamma_{212}=\gamma_{234}=\gamma_{313}=\gamma_{342}=\gamma_{414}=\gamma_{428}=+1;$$
$$\gamma_{221}=\gamma_{243}=\gamma_{324}=\gamma_{331}=\gamma_{432}=\gamma_{441}=-1;$$

the other forty-eight γ's are zero.

[1] Read before the American Mathematical Society, February 24, 1906.

[2] Dickson, "On Hypercomplex Number Systems," *Transactions of the American Mathematical Society*, Vol. VI, 1905.

[3] Octonians may be considered as quaternions with complex coefficients.

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Postulate I.—If a and b are any two quaternions, then $s=[a_1+b_1, a_2+b_2, a_3+b_3, a_4+b_4]$ is a quaternion.

Definition.—Addition of quaternions is defined by $a\oplus b=s$.

Postulate II.—$o=[o, o, o, o]$ is a quaternion.

Postulate III.—If o is a quaternion, then to any quaternion a corresponds a quaternion a' such that $a\oplus a'=o$.

Theorem 1.—Quaternions form a commutative system under addition. For, by postulate I, quaternions form an additive group. Addition is commutative because

$$\begin{aligned} a\oplus b&=[a_1+b_1,\ a_2+b_2,\ a_3+b_3,\ a_4+b_4]\\ &=[b_1+a_1,\ b_2+a_2,\ b_3+a_3,\ b_4+a_4]\\ &=b\oplus a: \end{aligned}$$

Postulate IV.—a and b being any two quaternions $a\otimes b=p=[p_1, p_2, p_3, p_4]$ is a quaternion, where

$$\begin{aligned} p_1&=a_1b_1-a_2b_2-a_3b_3-a_4b_4\ ,\\ p_2&=a_1b_2+a_2b_1+a_3b_4-a_4b_3\ ,\\ p_3&=a_1b_3-a_2b_4+a_3b_1+a_4b_2\ ,\\ p_4&=a_1b_4+a_2b_3-a_3b_2+a_4b_1\ , \end{aligned}$$

if the p_i are in D.

Definition.—The product of two quaternions is defined by $a\otimes b=p$.

Theorem 2.—Multiplication is not commutative. For, by postulate IV, $a\otimes b=$

$$[a_1b_1-a_2b_2-a_3b_3-a_4b_4\ ,\ a_1b_2+a_2b_1+a_3b_4-a_4b_3\ ,\ a_1b_3-a_2b_4+a_3b_1+a_4b_2\ ,\ a_1b_4+a_2b_3-a_3b_2+a_4b_1]$$

and

$$b\otimes a=[a_1b_1-a_2b_2-a_3b_3-a_4b_4\ ,\ a_2b_1+a_1b_2+a_4b_3-a_3b_4\ ,\ a_3b_1-a_4b_2+a_1b_3+a_2b_4\ ,\ a_4b_1+a_3b_2-a_2b_3+a_1b_4]\ .$$

$$\therefore a\otimes b\neq b\otimes a\ .$$

Theorem 3.—Multiplication is distributive.

For,

$$\begin{aligned} a\otimes(b+c)=[a_1, a_2, a_3, a_4]\otimes[b_1+c_1,\ b_2+c_2,\ b_3+c_3,\ b_4+c_4]=\\ [a_1(b_1+c_1)-a_2(b_2+c_2)-a_3(b_3+c_3)-a_4(b_4+c_4)\ ,\\ a_1(b_2+c_2)+a_2(b_1+c_1)+a_3(b_4+c_4)-a_4(b_3+c_3)\ ,\\ a_1(b_3+c_3)-a_2(b_4+c_4)+a_3(b_1+c_1)+a_4(b_2+c_2)\ ,\\ a_1(b_4+c_4)+a_2(b_3+c_3)-a_3(b_2+c_2)+a_4(b_1+c_1)] \end{aligned}$$

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$=[a_1b_1-a_2b_2-a_3b_3-a_4b_4+a_1c_1-a_2c_2-a_3c_3-a_4c_4\ ,\quad a_1b_2+a_2b_1+a_3b_4-a_4b_3$
$+a_1c_2+a_2c_1+a_3c_4-a_4c_3\ ,\quad a_1b_3-a_2b_4+a_3b_1+a_4b_2+a_1c_3-a_2c_4+a_3c_1$
$+a_4c_2\ ,\quad a_1b_4+a_2b_3-a_3b_2+a_4b_1+a_1c_4+a_2c_3-a_3c_2+a_4c_1]$

$=[a_1b_1-a_2b_2-a_3b_3-a_4b_4\ ,\quad a_1b_2+a_2b_1+a_3b_4-a_4b_3\ ,\quad a_1b_3-a_2b_4+a_3b_1$
$+a_4b_2\ ,\quad a_1b_4+a_2b_3-a_3b_2+a_4b_1]\oplus[a_1c_1-a_2c_2-a_3c_3-a_4c_4\ ,\quad a_1c_2+a_2c_1$
$+a_3c_4-a_4c_3\ ,\quad a_1c_3-a_2c_4+a_3c_1+a_4c_2\ ,\quad a_1c_4+a_2c_3-a_3c_2+a_4c_1]$

$=(a\otimes b)\oplus(a\otimes c)\ .$

Theorem 4.—Multiplication is associative.

$a\otimes(b\otimes c)=[a_1, a_2, a_3, a_4]\otimes[b_1c_1-b_2c_2-b_3c_3-b_4c_4\ ,\quad b_1c_2+b_2c_1+b_3c_4-b_4c_3\ ,$
$b_1c_3-b_2c_4+b_3c_1+b_4c_2\ ,\quad b_1c_4+b_2c_3-b_3c_2+b_4c_1]$

$=[a_1(b_1c_1-b_2c_2-b_3c_3-b_4c_4)-a_2(b_1c_2+b_2c_1+b_3c_4-b_4c_3)-a_3(b_1c_3-b_2c_4+b_3c_1$
$+b_4c_2)-a_4(b_1c_4+b_2c_3-b_3c_2+b_4c_1)\ ,\quad a_1(b_1c_2+b_2c_1+b_3c_4-b_4c_3)+a_2(b_1c_1$
$-b_2c_2-b_3c_3-b_4c_4)+a_3(b_1c_4+b_2c_3-b_3c_2+b_4c_1)-a_4(b_1c_3-b_2c_4+b_3c_1+b_4c_2)\ ,$
$a_1(b_1c_3-b_2c_4+b_3c_1+b_4c_2)-a_2(b_1c_4+b_2c_3-b_3c_2+b_4c_1)-a_2(b_1c_4+b_2c_3$
$-b_3c_2+b_4c_1)+a_3(b_1c_1-b_2c_2-b_3c_3-b_4c_4)+a_4(b_1c_2+b_2c_1+b_3c_4-b_4c_3)\ ,$
$a_1(b_1c_4+b_2c_3-b_3c_2+b_4c_1)+a_2(b_1c_3-b_2c_4+b_3c_1+b_4c_2)-a_3(b_1c_2+b_2c_1+b_3c_4$
$-b_4c_3)+a_4(b_1c_1-b_2c_2-b_3c_3-b_4c_4)]$

$=[(a_1b_1-a_2b_2-a_3b_3-a_4b_4)c_1-(a_1b_2+a_2b_1+a_3b_4-a_4b_3)c_2-(a_1b_3-a_2b_4+a_3b_1$
$+a_4b_2)c_3-(a_1b_4+a_2b_3-a_3b_2+a_4b_1)c_4\ ,\quad (a_1b_2+a_2b_1+a_3b_4-a_4b_3)c_1+(a_1b_1$
$-a_2b_2-a_3b_3-a_4b_4)c_2+(a_1b_4+a_2b_3-a_3b_2+a_4b_1)c_3-(a_1b_3-a_2b_4+a_3b_1$
$+a_4b_2)c_4\ ,\quad (a_1b_3-a_2b_4+a_3b_1+a_4b_2)c_1-(a_1b_4+a_2b_3-a_3b_2+a_4b_1)c_2+(a_1b_1$
$-a_2b_2-a_3b_3-a_4b_4)c_3+(a_1b_2+a_2b_1+a_3b_4-a_4b_3)c_4\ ,\quad (a_1b_4+a_2b_3-a_3b_2$
$+a_4b_1)c_1+(a_1b_3-a_2b_4+a_3b_1+a_4b_2)c_2-(a_1b_2+a_2b_1+a_3b_4-a_4b_3)c_3+(a_1b_1$
$a_2b_2-a_3b_3-a_4b_4)c_4]$

$=[a_1b_1-a_2b_2-a_3b_3-a_4b_4\ ,\quad a_1b_2+a_2b_1+a_3b_4-a_4b_3\ ,\quad a_1b_3-a_2b_4+a_3b_1$
$+a_4b_2\ ,\quad a_1b_4+a_2b_3-a_3b_2+a_4b_1]\otimes[c_1, c_2, c_3, c_4]=(a\otimes b)\otimes c.$

To make quaternions four dimensional we add a fifth postulate.

Postulate V.—If $\tau_1, \tau_2, \tau_3, \tau_4$ are elements of D, such that $\tau_1a_1+\tau_2a_2+\tau_3a_3+\tau_4a_4=0$ for every quarternion a, then $\tau_1=\tau_2=\tau_3=\tau_4=0$.

Theorem 5.—There are four quarternions, $\epsilon_i=[a_{i1}, a_{i2}, a_{i3}, a_{i4}]$ such that $|a_{ij}|\neq 0$.

By postulate V there is at least one quaternion different from zero. Let $\epsilon_1=[a_{11}, a_{12}, a_{13}, a_{14}]\neq 0$ be a quaternion where in particular $a_{11}\neq 0$. Consider ϵ_1 and also the quaternion $\epsilon_2=[a_{21}, a_{22}, a_{23}, a_{24}]$.

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There is at least one determinant of order two in the matrix

$$\left\| \begin{matrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \end{matrix} \right\|$$

which is not equal to zero. For if

$$\begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} = 0 ,$$

then considering $a_{22} = \tau_1$ and $a_{21} = \tau_2$ the expansion $\tau_1 a_{11} + \tau_2 a_{12} = 0$ gives by means of postulate V $a_{21} = a_{22} = 0$. But a_{22} may be assumed as any arbitrary non-zero element of D.

With ϵ_1, ϵ_2 consider $\epsilon_3 = [a_{31}, a_{32}, a_{33}, a_{34}]$ and assume $a_{33} \neq 0$. There is at least one non-zero determinant of order three in

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{vmatrix} .$$

For

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = 0$$

leads to the relation $a_{33}A_{33} + a_{32}A_{32} + a_{31}A_{31} = 0$, and by postulate V (since $A_{33} \neq 0$) $a_{33} = 0$.

Similarly it is seen that $|a_{ij}| \neq 0$.

§ 3. Identification with Ordinary Quaternions

The quaternion system as thus defined is holoedrically isomorphic with the quaternions of Hamilton, the coefficients belonging to the same domain D.

The quaternions $e_1 = [1, 0, 0, 0]$, $e_2 = [0, 1, 0, 0]$, $e_3 = [0, 0, 1, 0]$, $e_4 = [0, 0, 0, 1]$ form a four dimensional system since

$$\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \neq 0 .$$

By postulate IV and the definition of multiplication these quaternions e have the multiplication table

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	e_1	e_2	e_3	e_4
e_1	e_1	e_2	e_3	e_4
e_2	e_2	$-e_1$	e_4	$-e_3$
e_3	e_3	$-e_4$	$-e_1$	e_2
e_4	e_4	e_3	$-e_2$	$-e_1$

which, apart from symbolism, is the same as the table of § 1.

§ 4. On the Independence of the Postulates

If D is a domain admitting addition and subtraction, postulates II and III are redundant.

Aside from this case postulates I–IV are independent, as shown by the following systems:

(I) Elements 0, $[\pm 1, 0, 0, 0]$, $[0, \pm 1, 0, 0]$, $[0, 0, \pm 1, 0]$, $[0, 0, 0, \pm 1]$.

Postulate II holds, since 0 is an element.

Postulate III holds, since $[+1, 0, 0, 0]+[-1, 0, 0, 0]=0$; and $[0, +1, 0, 0]+[0, -1, 0, 0]=0$; $[0, 0, +1, 0]+[0, 0, -1, 0]=0$; $[0, 0, 0, +1]+[0, 0, 0, -1]=0$.

Postulate IV holds, since the product of any two elements gives an element.

Postulate V holds, since no mention is made of the r's.

Postulate I does not hold, since $[1, 0, 0, 0]+[0, 1, 0, 0]$ is not an element.

(II) D is the domain of positive integers.

Postulate I is true, since addition is possible.

Postulate III is dependent (conditionally) upon postulate II. Therefore it is not considered here.

Postulate IV holds for those values of a_i and b_i which make the p_i positive. The values which make the p_i negative are excluded by the statement of postulate IV and the definition of D.

No mention is made of the r's. Therefore postulate V need not be considered.

Postulate II does not hold, since zero is not an element.

(III) Set (II) with zero added.

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Postulates I, IV, V, hold for the same reasons as in (II).

Postulate II holds since o has been added to the domain.

Postulate III does not hold, since subtraction is not always permissible.

(IV) D is the domain of complex numbers, the a_i being pure imaginaries.

Postulates I, II, III hold, since addition and subtraction is always possible.

Postulate V need not be considered, as no mention is made of the τ's.

Postulate IV does not hold, since the product of any two elements is real.

(V) a_1 arbitrary; other a's zero.

Postulates I, II, III are true, since addition and subtraction are always possible.

Postulate IV is true, since multiplication is always possible.

Postulate V is not true, since, if $a_1\tau_1+a_2\tau_2+a_3\tau_3+a_4\tau_4=0$ where $a_2=a_3=a_4=0$, $\tau_2\tau_3\tau_4$ may have any values.

April, 1906.

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AREAL GEOLOGY OF LOWER CLEAR CREEK (COLORADO)[1]

By James Underhill

Introduction

The area under consideration, shown on the key map, Fig. 1, embraces the northern portion of what I have called the Evergreen Quadrangle, about 180 square miles, and the southern portion of the Black Hawk Quadrangle, about 60 square miles. I have also covered in great detail, as far as the dikes are concerned, the region embraced in the so-called Idaho Springs and Central City special maps, an area of about 18 square miles.

For the Black Hawk I had the excellent topographic map of the United States Geological Survey on a scale of 1-45,000, or about 1½ inches to the mile. For the special area I had the Idaho Springs and Central City specials on a scale of 1-12,000, or about 5 inches to the mile.

There being no topographical map of the Evergreen Quadrangle, one had to be made before geological mapping could be done, and this has been in part constructed as follows: Where the Georgetown and Black Hawk Quadrangles overlapped on the Evergreen Quadrangle, the topography of these maps has been used. On the south and east the topography of the Platte Cañon and Denver sheets respectively has been used. Surrounded as the Evergreen Quadrangle has thus been, it has been admirably checked on all sides. Several triangulation points of the U. S. Geological Survey on the Evergreen Quadrangle, with some other triangulation points on other quadrangles that may be seen from it, have been platted. Other points have been more or less accurately determined with the pocket sextant. Then the township lines were laid on with checks by the topographic sheets above mentioned, and finally the sections and their topographic "guesses"—for they are little better—were sketched in. These topographic features have been found reasonably accurate at the intersections with the township lines, but as a rule

[1] Presented to the Graduate Faculty of the University of Colorado in a partial fulfilment of the requirements for the degree, doctor of philosophy.

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absolutely unreliable in other places. These features, which consist usually only of the creeks, have been checked as well as may be by the pocket sextant, and also by pacing and courses taken with the Brunton Compass. The notes of the pipe-line for the City of Golden water-

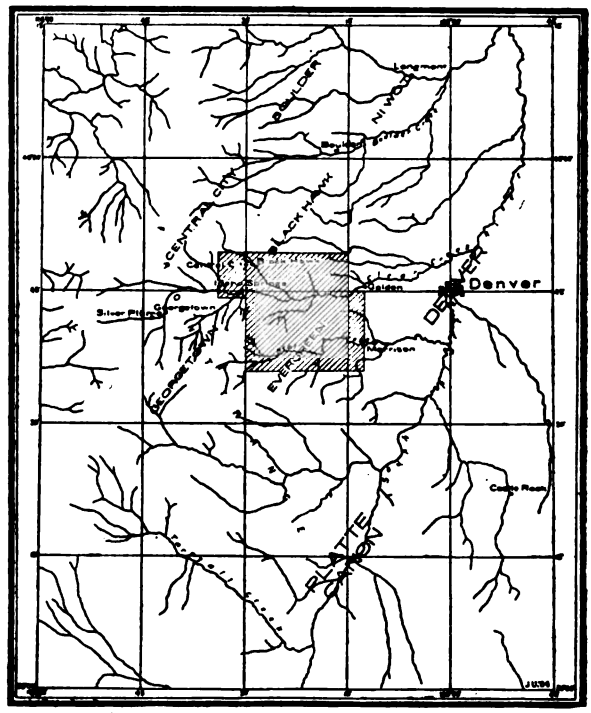

FIG. 1.

works kindly furnished by Mr. Carstarphen, the city engineer, have been of great service as a check on the northern portion of the Evergreen Quadrangle.

TOPOGRAPHY

The topography of the area in question may be divided into two divisions, the western and eastern sections. The topography of the western section is seen to be rugged, and, while not so much as the Georgetown and Central City Quadrangles to the west, its topography is more accen-

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tuated than the topography of the eastern section. The topography of the eastern portion may be defined as subdued topography, except where it is deeply cut by Clear Creek and Bear Creek.

Unlike the Georgetown and Central City Quadrangles, there is little evidence of glaciation. On the flanks of Squaw Mountain, especially at the head of North Beaver Creek, the amphitheater-like topography gives one an impression of a glacial cirque, and the idea receives confirmation by an accumulation of detrital material just at the beginning of the V-shaped valley of North Beaver Creek. To a less extent South Beaver Creek exhibits the same phenomena, and both creeks continue their courses as V-valleys. The subdued topography of the eastern portion strongly reminds one of a peneplain, and there is good reason to consider that all the eastern portion was once base leveled, and since has been deeply dissected on the north and south by Clear Creek and Bear Creek, and their respective tributaries.

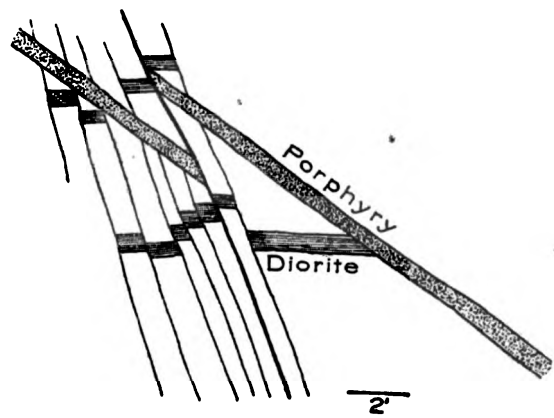

FIG. 2.

This peneplain or base-level was elevated in common with the remainder of the Rocky Mountains in Tertiary times, and Clear Creek and Bear Creek cañons with the cañons of their tributaries have been entirely eroded since that period. In many cases the side streams have not yet cut deep cañons, and we have at their sources the gentle, well-rounded slopes of Tertiary time, in sharp contrast with the deep cañons of the lower portions of the same streams. This is true also of the upper waters of Clear Creek and Bear Creek outside of the area here considered. In fact, a very close approximation to Tertiary topography could probably be reached in a topographic map of the eastern portion of the area under consideration by simply neglecting the deep cañons and putting in their

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place mature valleys with gentle slopes to represent the stream system of that time.

Geology

In nearly all the accounts of this region and the associated areas of the front range, especially those written some years ago, the rocks have been

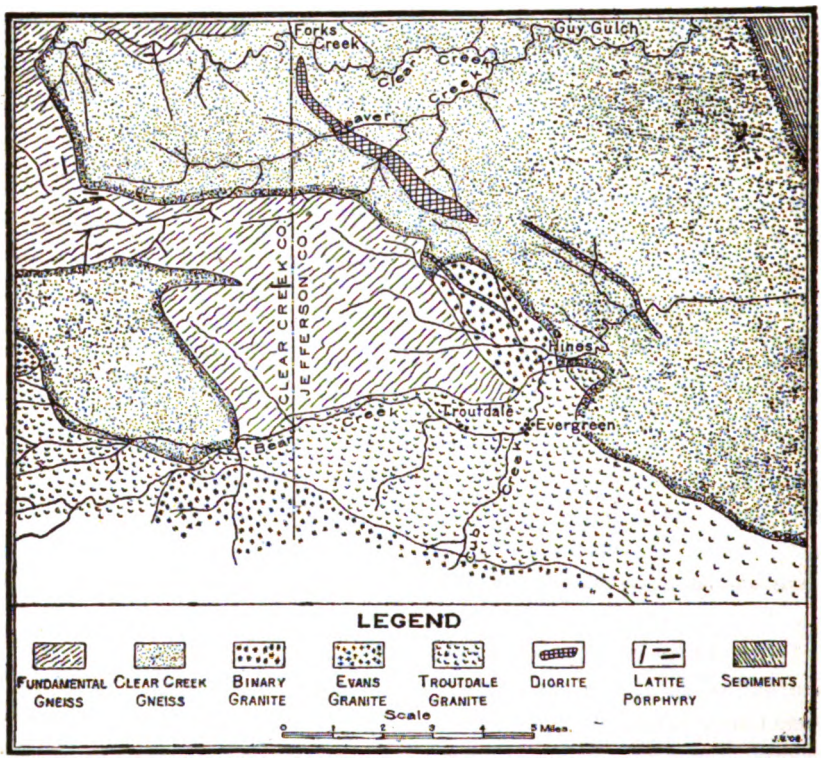

Fig. 3.—Portion of the Evergreen Quadrangle.

assumed to be of sedimentary origin, and so described. The banding has nearly always been regarded as the stratification, and thought to represent the dip of the original sedimentary rocks, from which the present complex was derived.

The geology of the lower Clear Creek area is a complex of presumably metamorphosed igneous rocks, usually designated as pre-Cambrian, but

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only certainly pre-Jura-trias, and then only for the main masses. That certain portions are of late eruptive origin can be proved, and possibly all of the country will some day be shown, as in the case of the Green Mountain area in Massachusetts, to be as late as Devonian.

That this supposedly pre-Cambrian complex was originally igneous and since metamorphosed by great dynamic forces, regional metamorphism, and thus as a consequence has taken on a well-defined schistosity,

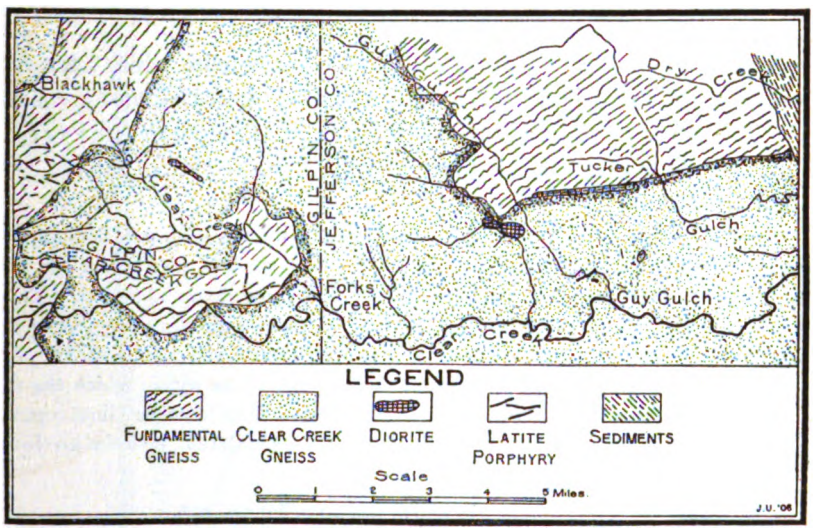

FIG. 4.—Portion of the Black Hawk Quadrangle.

is borne out by its comparative homogeneity over large areas in the field, and by the thin sections studied. It is difficult to believe that alternating strata and formation of sedimentary rocks could have been metamorphosed into such areas of homogeneous material as at present exist, and the appearance of the lithologic units as mapped up to the present strongly give the idea of an arrangement by igneous forces. While the complex of the lower Clear Creek area may be divided into a number of lithologic units with more or less certainty, in all probably about eleven or more, only ten can be recognized with certainty in the area in question. These formations beginning with the oldest, the Fundamental Gneiss, have been arranged as follows:

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Fundamental Gneiss
Clear Creek Gneiss
Binary Granite
Central City Granite (Evans Granite)
Troutdale Granite
Diorite
Pegmatite and Aplite
Latite Porphyry
Pleistocene and recent

The Fundamental Gneiss and Clear Creek Gneiss, while tolerably distinct as areas, grade into each other at their boundaries, and the situation can be best described by a quotation from *Monograph XXVIII*, U. S. Geological Survey, on the Marquette Region, by W. S. Bayley. On p. 151 he says:

> The foliated rocks occupy areas whose boundaries are not so well defined as is the case with the Marquette fragmentals. . . . . Nevertheless, an attempt has been made to map these areas. In their interiors the different phases of schists, granites and syenites are well characterized, but on their peripheries there is always a complex mixture of the various schists with one another or with the granite rocks. The respective colors on the map are believed to cover the areas within which the corresponding rocks predominate largely over other rocks. The boundary lines separating the different areas are drawn at about the places the different varieties are found in approximately equal quantities.

And again from the Ashville Folio (Folio 116, p. 4):

> In only a few cases do the boundaries shown on the map represent a single contact between two large masses; they usually indicate a narrow zone beyond which one rock or the other predominates. Sometimes an area shown as gneiss may contain many small beds of granite, or it may be substantially all gneiss. On the other hand, many of the areas represented as granite include also small bodies of gneiss. These may be continuous with one another or may be disconnected inclusions. Except where these bodies were the prevalent rock over considerable areas, they were disregarded in the mapping.

It might be added for the whole Clear Creek district that one outcrop may give examples of any or almost all of the lithologic units in question.

It is well known that pre-Cambrian areas have a close resemblance the world over. The lower Clear Creek area closely resembles other areas in the United States that have been most closely studied, as, for example,

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the Lake Superior, Southern Appalachian, Southern Colorado, and Grand Encampment regions.

FUNDAMENTAL GNEISS

Wherever in the Clear Creek section the rocks have been studied, this biotite gneiss is found to be with the Clear Creek Gneiss, the prevailing lithologic unit recognized and

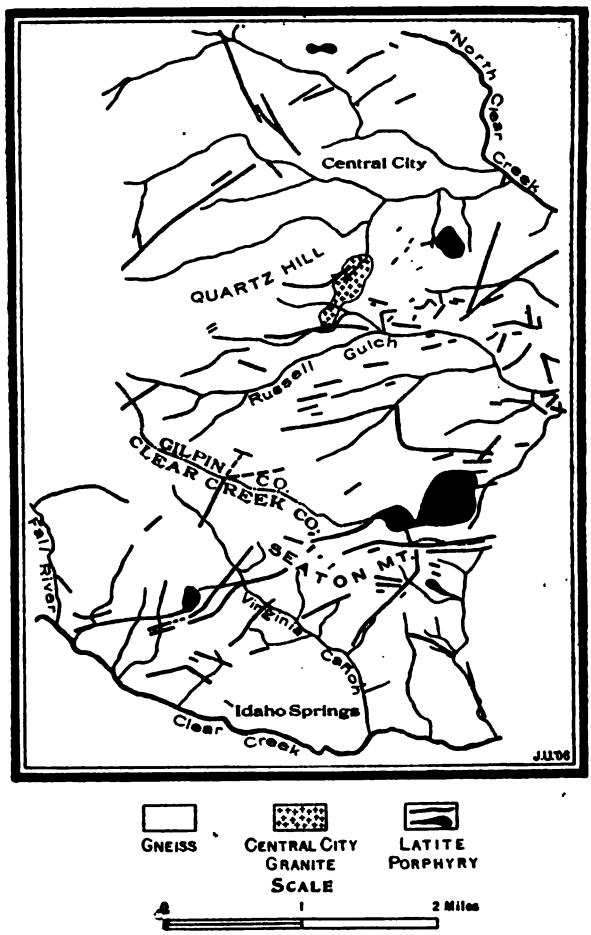

FIG. 5.—Idaho Springs and Central City Special Maps.

mapped. The Fundamental Gneiss as the prevailing rock is everywhere much plicated and crumbled, and shows signs of having been subjected to intense dynamic metamorphism. It is far more metamorphosed than any other rock of the country thus far studied,

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and is older than any other petrographic unit. Except where it is in contact with the Evans Granite, its schistosity or banding has a prevailing dip to the north at every possible angle. Its strike is east and west. Where in contact with Evans Granite, it dips away from the granite with a strike parallel to the contact. In the intense metamorphism resulting from pressure, it takes on the most fantastic and varied plications and crumplings possible, and every variety of folding to be found in any mountain region can, as a rule, be found here within a restricted area. The folding is accompanied by faulting, but, wherever possible to be determined, the resulting movements are for short distances only.

The history of the rock would seem to be that of an igneous rock exposed to great compression in the zone of flowage, and recrystallization of its materials along bands or zones. A subsequent folding followed, and afterwards faulting and jointing. The development of garnet and fibrolite described in the specimens is not universal, and the fibrolite gneiss does not seem to be developed according to any particular law. The garnets, on the contrary, have been observed in greatest development on the borders of the granitoid gneiss, in the Evergreen Quadrangle on the east, south, and west of the mass, though not on the north. This leads to the suggestion that the intrusion of Clear Creek Gneiss has developed the garnets in the Fundamental Gneiss as contact minerals.

The rock in the hand specimen is seen to be a fine-grained mixture of quartz, biotite, feldspar, fibrolite, and garnet in a general banded arrangement.

Microscopic.—Under the microscope the rock is seen to consist of a banded arrangement of biotite, quartz, frequently showing pegmatitic intergrowths with the feldspar, and undulatory extinction, and both microcline and plagioclase feldspar. Apatite is abundant. In many specimens, especially those from the Evergreen Quadrangle, there is an abundant development of fibrolite. This occurs as highly polarizing fibrous masses in parallel bands with the other materials of the section, and even penetrating the biotite, following the cleavage. Usually associated with the fibrolite is developed characteristic iron garnet, often in great abundance. In addition, we frequently find magnetite, hematite, apparently formed from the magnetite, rubellane mica, and occasionally hornblende, closely interwoven with the biotite. The specimens have every indication of an eruptive rock, greatly compressed and recrystallized, hence the banded structure. It nowhere shows any signs of having been a sedimentary rock, and if it ever was, it has been entirely remelted to the complete destruction of all former texture.

Clear Creek Gneiss

This formation occupies a large portion of the area under consideration, and while at some distance away from the Fundamental Gneiss it differs essentially from that unit, there is rarely any sharp contact between the two formations. The two nearest approaches to a sharp contact are to be seen in the eastern portion of the area studied. Here the contact transition zone probably occupies a space of about five hundred feet. On North Beaver Creek there is a space of about half a mile before either rock is prevailingly the unit mapped.

While the Clear Creek Gneiss shows the effects of having its banding or gneissic texture developed by great compressive forces, it has nowhere, except perhaps in the transition zone noted on North Beaver Creek, been so much plicated as the Fundamental Gneiss, neither has it suffered intrusion of pegmatite and diorite in so marked a degree as the

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Fundamental Gneiss. Like the latter, its dip is prevailingly to the north. It is predominantly the home of the latite porphyry dikes.

Microscopic.—The hand specimen consists of an evenly banded arrangement of quartz, feldspar, and mica, but without the plications usual in the Fundamental Gneiss.

Microscopic.—Under the microscope the rock is seen to consist of quartz, orthoclase, plagioclase, microcline, biotite, muscovite, magnetite, apatite, epidote, titanite, calcite, zircon, fibrolite, and hematite. Sericite is occasionally developed.

The quartz is generally in excess and shows in every case undulatory extinction. The feldspars appear as in the Fundamental Gneiss series, but in most cases show marked undulatory extinction. The muscovite and biotite occur as independent aggregates, and also frequently intergrown. The rock in question is distinguished from the Fundamental Gneiss series by its greater resemblance to a normal granite and by the smaller quantity of biotite.

For the areas covered by the Idaho Springs and Central City special maps no attempt has been made to separate the Fundamental Gneiss from the Clear Creek Gneiss on the map. There are two reasons for this.

In the first place, the two units are very intricately combined in one vast complex, which has been subjected to repeated fissuring and faulting. The faulting is not important, so far as the distance of movement is concerned, but when one considers the area affected, it assumes considerable importance. Then, too, this special area has been almost universally injected with pegmatite, and intruded by recent eruptive dikes. In addition to all this, we have the metamorphism of the rock by the subsequent, or usually subsequent, vein-filling solutions. All this causes a complex exceedingly difficult to unravel, and still more difficult to represent on a small scale map such as must be used in a report of this kind. It may be stated, however, that detailed notes have been taken for this area, and material for a reasonably exact map is at hand.

To anyone interested in the study of these Gneisses the Newhouse Tunnel offers an admirable section of some three miles in length. The direction of the tunnel in round numbers is about N. 15° W. At a few hundred feet south of the Gem vein the tunnel leaves the Fundamental Gneiss and cuts the Clear Creek Gneiss. This contact is still further to the south on the surface; in other words, the contact dips to the north at an angle of something like 45°. While some porphyry dikes have been cut in the Fundamental Gneiss, a far greater number are to the north in the Clear Creek Gneiss. The Fundamental Gneiss has been greatly plicated and more disturbed, it is true, than the Clear Creek Gneiss to the north, but it is in this latter that we can see most clearly, though not on such a large scale, the effects of dynamic action. This is fortunate, for in the narrow section cut by the Newhouse Tunnel every possible example of faulting and folding is in evidence in the course of a few thousand feet. These evidences of movement are rendered clear by the frequent alternating bands of black diorite and white gneiss, and strongly reminds one of the diagrams illustrating works on geology. In most cases the faults are not composed of one simple fault-plane, but are a series of distributive faults or fault zone. Frequently the fault-planes are so numerous and close together that we have simply a zone of sheeting. One of the very interesting occurrences is that shown on the west side of the tunnel just beyond the Sun and Moon vein (Fig. 2).

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Binary Granite

This granite occupies a small area just north of Hines' and a much larger area south of the Troutdale granite. No traverse yet made has reached the southern boundary of this mass. As this granite is easily weathered, it is almost impossible to find good outcrops, and it can be traced only by its residuals and by an occasional cutting. In this way we find the topography of the area occupied by the Binary Granite subdued, and relatively rolling with well-rounded slopes, especially in comparison with the Troutdale Granite area.

Petrography.—In the hand specimen this rock consists essentially of an intimate mixture of quartz and red feldspar.

Under the microscope the quartz is seen to have an undulatory extinction. The feldspar is, as a rule, microcline, with some acid plagioclase and occasional orthoclase. The accessory minerals are apatite and biotite occurring in small amount.

Central City Granite

This rock, so far as known, occurs only on each side and a little to the south of the head of Spring Gulch just south of the Central City Railroad Station. It is very clearly a mass of granite intruded into the surrounding gneiss, with which it forms a sharp contact to the north on the road to Central City. With the exception of a small hill on its most southerly extension, this granite is easily disintegrated and forms characteristic well-rounded outcrops.

Petrography.—In the hand specimen this granite proves to be a hypidiomorphic arrangement of quartz, feldspar, and biotite. There is a suggestion of a banded arrangement, which is more evident in the larger masses.

Under the microscope the quartz shows the results of dynamic action by its undulatory extinction. The feldspar is found to be nearly all an acid plagioclase, with some few grains of orthoclase. There is an abundance of biotite, also a little hornblende. Apatite, titanite, magnetite, and zircon occur in the usual form of these minerals.

The rock is classed with the alkali granites or granitites.

Evans Granite

This granite occupies a small area on the western portion of the Evergreen Quadrangle. It strongly resembles the Central City Granite, and is very likely the same petrographic unit. No petrographic determination was made of this rock.

Troutdale Granite

As can be seen from the map, this petrographic unit occupies a territory on either side of Bear Creek, from a point just east of the town of Evergreen to the western boundary of the Evergreen Quadrangle. It shows every evidence of being a true eruptive granite, and in many cases along Bear Creek, at best just west of Troutdale, are seen apophyses of granite in the Fundamental Gneiss. This has been called the Troutdale Granite on account of its picturesque development at the resort of that name. It is probably, judging from the comparison of hand specimens, the same granite that occurs at Georgetown, Colo., though, so far as known, there is no direct connection. While not found cutting the Binary Granite, there is good reason for thinking it is younger, especially as it seems to divide the Binary Granite into two masses. The topography of the area occupied by

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the Troutdale Granite is rough and accentuated, forming in many cases deep cañons with steep walls and picturesque towers of rock. This area is in marked contrast with the subdued areas to the north and south.

Macroscopic.—In the hand specimen this granite appears as a hypidiomorphic mixture of quartz, red or pink feldspar, and biotite.

Microscopic.—Under the microscope we find that the quartz has a slight undulatory extinction at times; the feldspar is chiefly an acid plagioclase with some orthoclase and microcline. The microcline frequently shows Carlsbad twinning in addition to the characteristic cross-hatching. Sometimes the feldspar is seen in pegmatitic intergrowths with the quartz. The feldspar is frequently found altered to sericite. In addition to these minerals, we have muscovite, apatite, titanite, magnetite, and zircon.

This is also an alkali granite. It differs from the Central City granite in the less amount of femic or ferro-magnesian minerals, and in the presence of muscovite, wanting in the Central City Granite.

Diorite

The next lithologic unit of importance is represented by the numerous diorites, of which one large mass east of Creswell is particularly interesting. This mass, extending nearly to Clear Creek Canon, turns toward the southeast to a point north of Bear Creek. Except in several local instances, this rock is a massive diorite, and shows little or no evidence of dynamic metamorphism, though there is good reason to believe, from the study of the specimens collected and examined, that chemical metamorphism has been active.

Besides this large mass of diorite, there are everywhere present in the Fundamental Gneiss, and to some extent in the Clear Creek Gneiss, small dikes of diorite, for the most part parallel to the schistosity or banding, and, while almost without exception greatly sheared and squeezed by dynamic forces, are but rarely plicated. These, while not so extensively metamorphosed as the inclosing rock, are still greatly affected by the same or similar forces. The greater metamorphism of the smaller dikes seems to imply either a greater age for these intrusions, as a rule, than for the larger mass of diorite, or else a less ability to withstand the forces of metamorphism than was possessed by the larger mass of diorite. No attempt has been made to map these smaller dikes, only the most important receiving attention.

Macroscopic.—The rock consists of an even grained holo-crystalline mixture of hornblende and plagioclase feldspar. In many specimens and in the larger masses of rock, as a rule, there is no striking evidence of banded texture, but some specimens have a banded appearance which at times becomes schistose. In some of the dikes there is a marked coarse-grained texture, strongly suggestive of a typical gabbro, and here the component minerals occur in large crystals with abundant development of garnet.

Microscopic.—Under the microscope the rock is seen to consist essentially of a holocrystalline mixture of green hornblende and plagioclase, with some biotite, augite, quartz, apatite, magnetite, titanite, epidote, garnet, and secondary calcite and actinolite; the whole, as a rule, taking on a banded arrangement.

The hornblende is of the common green variety, showing basal sections predominating, with the usual two prismatic cleavages. It is, as a rule, distinctly pleochroic, but in some specimens shows only the faintest pleochroism. In the strongly pleochroic

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varieties we have a=yellowish green, b=dark green, c=yellowish green. Absorption showing $c=b > a$. The feldspars are all striated, showing polysynthetic twinning according to both the albite and pericline laws. As no examples of Carlsbad twinning were observed, it was found impossible to determine the plagioclases according to the method of Michel-Lévy, but, as the extinction angles average about 15° and one as high as 40° was observed, the composition is probably about oligoclase-andesine. Nearly all the feldspars show undulatory extinction, showing that they have been exposed to great pressure, but at the same time not so much as would be expected from the appearance of many of the hand specimens. This would seem to imply that considerable recrystallization had taken place.

In the very coarse-grained varieties an iron garnet is very abundant. Inclosed in the garnet have been noticed quartz, plagioclase, and hornblende. The other minerals mentioned above present the usual aspects.

Pegmatite and Aplite

Every rock noticed in this district has been intruded by pegmatite and aplite, usually acid in nature, but more rarely, as in the case of the diorite pegmatite described for Guy Gulch, and also another occurrence near the Gem power plant on Clear Creek, basic in composition. These pegmatites, intruded in every imaginable way into older rocks, have the most fantastic and varied cross-section. They frequently carry great quantities of magnetite, which afterwards supplies in great part the black sands and pebbles in the placers. Locally, graphic granite is often developed, probably at its best near Roscoe on Clear Creek. The pegmatite rarely shows evidences of having been subjected to great dynamic forces. It has a common development near bodies of sheared diorite.

It has been found impossible to map satisfactorily the pegmatite injections, and for this area no attempt has been made in this direction. Some petrographic descriptions of these rocks are, however, added.

Pegmatite (*Graphic Granite*). Roscoe, by C. & S. tracks

Macroscopic.—The rock consists of bands or pencils of quartz and feldspar showing on cross-section the common graphic texture.

Microscopic.—Under the microscope the rock is seen to consist of alternating bands of quartz and microcline, the former showing undulatory extinction, giving in one place the appearance of twinning. The microcline has the usual cleavage texture, but with one cleavage developed parallel to the quartz, the other at right angles. This would seem to indicate a continued pressure in one, or perhaps two, definite directions.

Aplite. N. W. Corner of Evergreen Quadrangle

Macroscopic.—The rock is a pegmatitic rock consisting of quartz, feldspar, and some pyrite. The specimen is traversed by a small vein of oxidized material.

Microscopic.—The rock under the microscope is seen to consist of a medium fine-grained holocrystalline mixture of quartz, microcline, and some orthoclase, with small amounts of pyrite, magnetite, and muscovite. The quartz shows undulatory extinction, and the whole rock shows signs of compression, and effect of dynamic forces, as is also suggested by the microcline twinning. The specimen is seen to be traversed by a small vein consisting of oxidized material, and here the feldspars have been impregnated and somewhat altered.

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DIORITE PEGMATITE. Guy Gulch, by C. & S. tracks

Macroscopic.—The hand specimen is a rather pegmatitic-looking mass composed entirely of hornblende, feldspar in most cases striated, and black mica.

Microscopic.—Under the microscope the rock is seen to consist of a coarse-grained aggregate of green hornblende, biotite, plagioclase, orthoclase, the former predominating, together with a little quartz, apatite, epidote, calcite, titanite, and magnetite, all exhibiting the ordinary characteristics of these minerals. The quartz and feldspar show frequent pegmatitic or granophyric intergrowths. The plagioclase appears to have a low extinction angle, and to be near the albite end of the series, probably oligoclase.

LATITE PORPHYRY

In certain portions of the district in question, notably the areas covered by the special maps, and also in the western portion of the Black Hawk Quadrangle, the country is extensively traversed by porphyry dikes. While these dikes run in every direction, the majority of them have a course N. E. by S. W., or the same as the prevailing vein system. It is interesting to note that, while there are no veins of importance outside of the area traversed by the dikes, the area of the dikes at the same time extends beyond the area traversed by the important veins. These dikes vary in size from a few inches to hundreds of feet in width, and from a few feet to many miles in length. As a rule, however, they die out in a few hundred feet. In the field they all have the same general characteristics, and vary in color from brown and red to gray. They are reasonably straight, but dip at all angles, though, like the veins, in the majority of cases the dip is rather steep.

At various points all over the area studied, and especially near veins, the dikes have been brecciated, and in some cases the fragments in every way resemble water-worn pebbles. These occurrences have been explained as true conglomerates of as early as Algonkian time, notwithstanding the fact that there is good reason to consider the porphyry composing the pebbles as Tertiary. The phenomena have also been explained as resulting from the fall of water-worn pebbles into open crevices. The true explanation of the phenomena probably is the extensive brecciation and complete shattering of the dike. Subsequent kneading movement, possibly aided by solution, reduced the angularity of the fragments, and in some instances gave them the appearance of water-worn pebbles. The best places to study these phenomena are Banta Hill and the so-called "Queen's Chair."

The dikes, as a rule, are closely "frozen" to the inclosing walls, and, though carefully sought for, in but one case was any sign of contact metamorphism observed. That there has been shrinking in cooling is evident by the lines of fracture when the rock is broken.

It is difficult to obtain fresh specimens on the surface, and when near veins they are also greatly decomposed, as a rule. The best specimens are to be procured in cross-cut tunnels outside of the vein area and in newly made roads. The dikes usually have a fine-grained appearance when fresh, and the porphyritic appearance and the display of phenocrysts, as a rule, are the result of weathering or underground decomposition. In the hand specimen the rock varies through all the stages from what might be called a felsite, which is all ground-mass with no phenocrysts, to a granite porphyry which has little ground-mass, and which might be said to be all phenocrysts. This latter phase is often taken for a granite and not regarded as a porphyry at all. Those rocks locally known as porphyry

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have been described by every name from andesite to phonolite in different reports. They do vary from the composition of andesite to that of trachyte, but in the area specially studied they are of intermediate composition, and may be called Latite Porphyry.

It is very possible that they are the necks of surface flows which furnished the andesite pebbles for the beds of the Denver Formation.

Microscopic.—Under the microscope the porphyries vary from a rock composed of a holocrystalline ground-mass of quartz and feldspar with no phenocrysts, to a rock with little ground-mass and resembling the true granite. As a rule, the ground-mass is a fine-grained granitic mosaic, and might be called a micro-granite. In many specimens, especially those that are highly iron-stained and rich in magnetite and hematite, the feldspars are lath-shaped, and the quartz is allotriomorphic to the feldspar and arranged in the spaces left over after the consolidation of the feldspar. Here in many cases the feldspars are iron-stained all through; in other cases the stain has not penetrated to the center. The lath-shaped feldspars have here usually taken on a rough flow structure. In the case of vein breccias and the more andesitic varieties the ground-mass may resemble a felted paste. The highest powers of the microscope fail to resolve this paste into its component minerals.

In the ground-mass, of whatever character, as a rule are larger crystals of phenocrysts of one or more generation. The larger crystals are generally plagioclase, with some orthoclase. These nearly always show evidences of zonal development, and are of intra-telluric formation. The feldspars frequently show evidence of rebuilding. The crystals of a second growth are the same as those of the first growth, but, as a rule, rather more acid, with quartz, biotite, and hornblende. In no case in this area has the quartz been seen in large crystals, though one dike on Mill Creek studied outside of the area shows good quartz phenocrysts, with perfect crystalline outlines. All these larger crystals have suffered more or less from corrosion by the magma before the consolidation of the ground-mass. This is especially true of the biotite and hornblende crystals, of which in many cases only the skeletons remain for identification. In one case portions of the ground-mass were noticed entirely inclosed in a phenocryst of feldspar. Among the earliest consolidations are apatite and titanite, frequently in relatively large and well-formed crystals. In the ground-mass, and in addition to the quartz and feldspar previously noticed, are found pyrite, magnetite, biotite, hornblende, augite, hematite, zircon, and in one case fluorite. Sericite, epidote, zoisite, calcite are present as alteration products, with frequent secondary quartz.

Pleistocene and Recent

At several places noted previously under glaciation, and also at various points in Clear Creek Cañon, gravel deposits have accumulated. On the northwest portion of the Evergreen Quadrangle by the Silver Age Mill on the north side of Clear Creek, and also nearly opposite Sawmill Gulch, on the north side of Clear Creek, the remains of an old stream terrace can be seen about one hundred feet above the present stream-bed. These correspond to the old terraces which are more prominently developed on the Georgetown Quadrangle around Idaho Springs. Some of these are more or less completely consolidated into conglomerates.

Sediments

No attempt has been made to map the sediments which have been described in the Denver Monograph.

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VOLUME IV NUMBER 1

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

DECEMBER, 1906

Price, 50 Cents

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THE UNIVERSITY OF COLORADO STUDIES

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EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

DECEMBER, 1906, TO JUNE, 1907

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THE EPIGRAM AND ITS GREATEST MASTER, MARTIAL[1]

By Fred B. R. Hellems

When discussing this topic some years ago in one of our larger universities I found a rather puzzled uncertainty among my students about the range of the word "epigram." As they looked in half-derisive pity upon the significantly receding bay in my once less scanty hair, they agreed unhesitatingly to accept as an epigram Walter Savage Landor's playful plaint against a trick of Time:

The burden of an ancient rhyme
Is "By the forelock seize on Time!"
Time in some corner heard it said;
Pricking his ears away he fled;
And seeing me upon the road
A hearty curse on me bestowed.
"What if I do the same by thee?
How would'st thou like it?" thundered he,
And without answer, thereupon,
Seizing my forelock, it was gone.

They welcomed likewise Porson's caustic comment written when the flow of learning among the divinity men of the English universities was as low as the flood of good old port was high:

Here lies a Doctor of Divinity,
He was fellow too of Trinity.
He knew as much about Divinity
As other fellows do of Trinity.

There was some little doubt, however, when I proposed William Watson's glorious protest against the myopic and arrogant vision that sees no ultimate riddle of the universe.

Think not thy wisdom can illume away
The ancient tanglement of night and day.
Enough to acknowledge both and both revere;
They see not clearliest who see all things clear.

[1] (Reprinted from *Post Lore*, Vol. XVI, No. 4, pp. 67–77, by permission of the publisher.)

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But, of course, this last is quite as truly an epigram as Landor's lament or Porson's epitaph, and is happily covered by Klopstock's admirable definition in verse:

Bald ist das Epigramm ein Pfeil,
Trifft mit der Spitze;
Ist bald ein Schwert,
Trifft mit der Schärfe.
Ist manchmal auch—die Griechen liebten's so—
Ein klein Gemäld! ein Strahl gesandt,
Zum Brennen nicht, nur zum Erleuchten.

[By times the epigram is an arrow, wounding with its point; by times 'tis a sword, wounding with its keen edge. Ofttimes, too,—in this guise the Greeks loved it,—'tis a miniature, a beam sent, not to burn, only to lighten and brighten.]

With the etymology of the word "epigram" before our minds, we need not state formally either the land of its birth or its original application. When the Greek cut an inscription on a tomb, a tripod, a pillar, or any other enduring object, he termed what he had written simply an *epigramma.*

If we recall the priority of verse to prose as the channel of artistic or even formal expression, we shall expect to find such an inscription falling into metrical form, and Herodotus, first and best beloved of all the tribe of reporters, has transcribed from some temple tripods a couple of hexametrical inscriptions which were confidingly reported to be as old as the days of Laïus, father of Oedipous.

In the beginning the exigencies of space would compel brevity, often limiting the inscription to a single line or a couplet, and in Greece even the later epigram is seldom found running beyond a modest length, although at Rome it often loses this primitive merit. Furthermore, the form and style of the epigram are intimately connected with this compulsory brevity. If the writer has only a line or two in which to express grief for a son's untimely death, to laud a high-souled hero, or to honor a notable deed, he does not trifle away his space, but with all his power strives for conciseness and finish; and these qualities remain characteristic of the epigram long after its original bounds as to subject have been overpassed and forgotten.

The subject of the earlier epigram is naturally associated closely with

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the object on which it appeared. A tomb might be inscribed with a father's brief but bitter plaint that he had laid therein his darling son, his life's high hope. A pillar might be eloquent with words in which the poet glorified the transcendent fidelity of those who died battling for the fatherland. "These men, having set a crown of imperishable glory upon their own land, were folded in the dark cloud of death; yet being dead they have not died, since from on high their excellence raises them gloriously out of the house of Hades."[1] On the base of a statue of Niobe by Praxiteles an enthusiastic admirer might inscribe: "From life the gods turned me into stone, and from stone Praxiteles wrought me back again to life." On a rock beside a spring some tuneful wayfarer in dusty Attica might cut this dainty invitation:

Stranger, by this worn rock thy limbs repose;
Soft through the verdant leaves the light wind blows;
Here drink from the clear spring at noonday heat,
Such rest to way-worn travelers is sweet.

But these examples have carried us to the point where the epigram is no longer of necessity an inscription, but is still a poem that might have been inscribed, and thenceforward we find the epigram treating any theme that can be compassed in a few lines. Strato may hymn in unsurpassed lyric verse the love that dies not and the beauty that age may alter but cannot lessen:

O how I loved when like the glorious sun
  Firing the Orient with a blaze of light,
The beauty every lesser star outshone!
  Now o'er that beauty steals the approach of night.
Yet, yet, I love! Tho' in the western sea
Half sunk, the day star still is fair to me.

Even greater than the beauty unquenched by age is the beauty that is undimmed by death:

Thou wert the morning star among the living,
  Ere thy fair light had fled,
Now, having died, thou art as Hesperus, giving
  New splendor to the dead.[2]

[1] The rendering is by Mackail, one of our best translators; but it fails to convey the effective beauty of the original.

[2] Despite my unbounded love for Shelley, I can but feel that this rendering by him falls short of the Greek. Merivale has been more successful, but with the easier preceding epigram.

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Occasionally, however, even under kindly Athena's sky the epigram takes on a radically different tone. An ill-starred bachelor will have this appealing epitaph, which surely represents the quintessence of pessimism, well preserved in Cowper's translation:

At three-score winters' end I died,
A cheerless being, sole and sad.
The nuptial knot I never tied,
And wish my father never had.

Another misogamist snarls that the man who seeks second nuptials is a foolish sailor, who after having been shipwrecked once sails again a treacherous gulf. Or a waggish detractor pierces a physician with this shaft:

Pheido nor hand nor touch to me applied;
Fevered I thought but of his name and died.

But on the whole the snarl and the bitter shaft are rare. The Greek epigram is more often lyric, idyllic, or epideictic rather than epigrammatic according to the Roman and modern conception, so that Herder's exquisite quatrain marks out a real line of divergence. The Greek epigram speaks:

Dir [Martial] ist das Epigram die kleine geschäftige Biene
Die auf Blumen umher flieget und sauset und sticht;
Mir ist das Epigram die kleine knospende Rose
Die aus Dornengebusch Nektarerfrischungen haucht.

[For you the epigram is a little busy bee that flits about on the flowers, and buzzes and stings; for me it is a tiny burgeoning rose that from the bush of thorns breathes such quickening as nectar might bestow.]

In Italy every variety of epigram that had sprung up in Greece was reproduced as well as the difference in genius between the two peoples would permit. As an actual inscription it was employed by the Romans with a frequency sometimes overlooked. In literature the formal epigram appears in Ennius, the father of Latin poetry, and thenceforward never lacks representation. Quintus Lutatius Catulus, Licinius Calvus, and many others are little more than names to most readers, and it is not often recalled that the imperial hand of Augustus toyed with this form of composition. Catullus and Martial, however, are familiar to all and have come to be synonymous with epigram. In fact, the more incisive

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and aggressive employment of this form by these two writers, particularly by Martial, gave the word a new meaning:

> Omne epigramma sit instar apis, sit aculeus illi.
> Sint sua mella: sit et corporis exigui.
>
> The qualities rare in a bee that we meet
> In an epigram never should fail,
> The body should always be little and sweet
> And a sting should be left in the tail.
>
> —*Panorama of Wit*, 1809, p. 250.

These lines, notwithstanding the protests of accurate scholars, continue to express the ordinary understanding of epigram, and this fact is due very largely to Martial's influence. Indeed, so closely does the theory of this couplet correspond to much of Martial's practice that it was attributed to his authorship by a long-persistent error.

That Martial was the greatest of epigrammatists was stated by Lessing in his still valuable treatise on the epigram, and has been reiterated by many men of less authority. It is easy to abuse Martial; but it is impossible to procure a reversal of this general verdict. Relatively to the other great Latin authors Martial is at present little read, and for one student who is familiar with the molder of the modern epigram the readers of Horace or Vergil may be counted by scores or even hundreds. Of this neglect a talented Frenchman has offered an explanation in a delightful article in the *Revue des Deux Mondes* for July 15, 1900. "Martial is little read in France," says M. Boissier, "and the poet himself is to blame, because his works with all their wit and charm contain disgusting obscenities which render it dangerous to speak to younger people of the *jolies choses* for fear of inspiring them with a desire to read the rest." Thus the youth of Paris are guarded from the perils of the deep. Previous generations of Frenchmen, however, were not so paternally sheltered, as is shown by Martial's tremendous influence on French literature, nor have common-sense Germany and respectable England refrained from the fullest enjoyment of his genius.

Martial was born on a fourth of March between 38 and 41 of our era. His parents lived in the little town of Bilbilis in central Spain and gave their son an excellent education, which was probably begun in his

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native town and continued in some neighboring city. This education would not differ in any essentials from that of a boy trained at Rome, for Spain had devoted herself enthusiastically to the same culture as that of the imperial city, and was already sending thither successful teachers. At this period Rome had the same attraction for a youth "suffering from literary aspirations" that Paris or London or New York has so often exercised on his modern counterpart; and this attraction would be all the stronger for Martial by reason of the number of influential Spanish houses already established at the capitol. To Rome, then, he went as a sanguine youth in 64 A. D., and in most respects became more of a city man than his contemporaries who first saw the light in the Bowery of Rome, the *fervens Subura*. Of the earlier years spent there we know little. He doubtless prepared for work as an advocate, and very probably wrote poems, some of which may have been revamped for publication after he acquired vogue. In the year 80 A. D., however, when the great Flavian amphitheater, now known as the Colosseum, was dedicated with spectacles on a stupendous scale, he came into prominence with some suitable epigrams; and from this year on we can gather many details of his round of life. For a time he lived in rented quarters which learned commentators have felt justified in describing as "poor and humble," because the poet playfully states that they are "three flights back." But during the last four or five years of his sojourn in the metropolis he was the respectable proprietor of his own dwelling. He owned a little estate at Nomentum which he wittily derides in pleasantries that must not be taken as legal evidence. He was always importuning his friends for money or goods, and was always impecunious, probably as a result of generous Bohemian expenditure rather than of an oppressively meager income. At any rate, he managed to live the life of a fashionable man of letters, thoroughly after the manner sung of in Goethe's "Genialisch Treiben."

Bald ist es Ernst, bald ist es Spass.
Bald ist es Lieb, bald ist es Hass.
Bald ist es dies, bald ist es das.
Es ist ein Nichts, und ist ein Was.

[Now it is earnest, now it is jest. Now it is love and now it is hate. Now it is this, and now it is that. It is a nothing and it is a something.]

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He made friends and enemies, won sweet favor and bitter envy; he walked and talked, dissipated deeply and slept lightly; he frequented theater and bath, library and club; he ran to the country when tired of the town, and returned to the town when tired of the country; he dined much and dreamed a little; he observed some of the virtues of his fellow-men and women, and all of their vices; he wrote good poems and bad; and achieved fame and unhappiness. Then after thirty-four years the quiet rural life he had deserted took its revenge, as it so often does on its successful but embittered children, and brought him back to the peaceful scenes of his native province. A generous patroness provided him with an estate that both delighted the mind and supported the body, and here he seems to have been fairly happy save for the rasping gossip of the tiny village and his inevitable longing for the delights of the capital. It was amid the old scenes that he passed away, lacking about ten years of the three score and five which he had prayed the grim sisters three might spin for him.

Martial's popularity was immediate and general. He was read much, not only at Rome, but also in the remote parts of Rome's dominions for many centuries. Even during the Middle Ages he did not fall into such neglect as was the lot of many Latin writers, and with the "Renaissance" he came rapidly into his own, or even more than his own.

Of the reasons for Martial's triumph it is always easy to write at length; but they generally come back to the fact that he has put before us the frailties of human nature in unforgettable verses. You cannot forget Martial any more than you can escape human nature with its mingled yarn of good and ill together. "My page is life," he asserts; and his claim is largely true, although it is not all of life. This is unquestionably the reason that his pages are ever fresh, and that his jests make newer jests seem old. Years ago Mark Twain was credited with a *mot* that the younger generation seems to have forgotten. "There are but thirteen jokes in the world," he said, "and Aristophanes and Martial had twelve of them. Modesty prevents me from mentioning the author of the thirteenth." The commonplace that there is no new joke is true in foundation; for the modern joke is simply its ancient forerunner adapting itself to a new environment.

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From Martial's pages we may evoke all the old familiar faces of jest and epigram with no magician's wand to aid us:

The golden hair that Galla wears
Is hers. Who would have thought it?
She swears 'tis hers and true she swears,
For I know where she bought it.

'Twas that mellowest of epigrammatists, Sir John Harrington, that gave Galla her English dress; but Martial had presented her in Latin. And here I must break my paragraph to apologize to the spirit of old Sir John for all the countless throng who have forgotten or never learned that he was the author of that peerless flower of English epigrams:

Treason doth never prosper. What's the reason?
For if it prospers none dare call it treason.

In Galla's train come all the women who have sought to remedy the unkindness of nature by the ingenuity of man, and they have been many. "Thais has black teeth, Læcania white; the former has her own, the latter wears purchased ones." These two ladies have appeared often enough in English garb, but even more often in French:

Rien de plus noir que les dents d'Alizon,
Rien de plus blanc que les dents de Fanchette.
Devinez-vous quelle en est la raison?
L'une a ses dents, et l'autre les achète.

Such is the adaptation by M. de Morvilliers; but more than a score of others in French are known to me, and there are doubtless as many others that I have missed. A purchaser of ivory teeth and false hair in the world of letters is the plagiarist who wishes to be thought a poet by the aid of Martial's verses. "In the same way in which you are a poet you may have tresses when you are bald." This summons before us the man of "shining hairless pate" at whom Martial wings many merciless jests which do not seem nearly so laughable to me now. Straight back to Homer and the Old Testament can we trace this mocking at the footprints of age; but not often do the avenging bears appear. However, if Martial was often witty on a theme unwelcome to many of us, he was not less often witty on a theme over which his heart was not always light,

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for his eyes were ever toward the lender of money, and his purse was generally filled only with cobwebs.

> Lend Sponge a guinea! Ned, you'd best refuse
> And give him half. Sure that's enough to lose.

But now the faces no longer wait to be summoned, they are fairly streaming past us. The aged dame wedded for her attractive combination of accumulated wealth and wasting cough; the well-matched couple who ought to agree better because they are so thoroughly alike, "each as bad as bad can be;" the shopper who handles all the richest wares from the highest shelves and spends a farthing; the representative of the *jeunesse dorée* who does everything prettily, almost "'cutely," from tennis to astronomy; the beau who sends countless *billets-doux* and receives none; the busybody who whispers mysteriously in your ear what might be proclaimed from the housetops; the lawyer who "runs on from Magna Charta to old King John," but utters never a word about the sheep—all of these belong no more to Roman life two thousand years ago than to American life in the twentieth century.

But where shall we interrupt this line of hurrying faces? The coachman who brought a double price because he was deaf comes to claim as his descendant the canny caddy who is blind enough for two. The young Roman society man reciting his own verses after pleading the adequate excuse of a sore throat sees a congenial sister in the young society woman who sings in spite of such a cold. At some of the faces we must glance twice before they are recognized. "Who are you?" "I was the victim of many fires who always received generous contributions from kindly friends until I burned my house once too often." "And who are you now?" "I am the insurance joke, without which Life would die." "Who were you with the laughing half-offended face?" "I was Baiae, sweetest of seaside resorts, always maligned as the cause of too many flirtations." "To me," Martial said, "a lady came a Penelope and from me departed a Helen." "And who are you now?" "I am Ostend or Saratoga or any other sea-and-sun-kissed strand where a man and a woman search each other's eyes for the little winged god and remember or forget." With these our line of faces has only begun; the others are just as familiar, but we must let them flit by unnoted.

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Another phase of interest attaching to Martial is his constant reappearance in unforeseen places. In Herrick or Ben Jonson or countless kindred spirits we should naturally look for many traces of Martial, and should find them in even greater abundance than we had looked for; but Martial is not bounded by the expected. For instance, from the tongues of all of us there runs lightly off:

I do not love you, Dr. Fell;
The reason why I cannot tell.
But this I'm sure I know full well,
I do not love you, Dr. Fell.

We do not remember, however, that the original is Martial's, "I do not love you, Sabidius, nor can I say why; I can only say this, I do not love you." Indeed, the story goes that the immortal Dr. Fell, bishop of Oxford in the latter half of the seventeenth century, was interviewing one Tom Brown about a threatened rustication and was seeking any possible excuse for being merciful. Finally the bishop said to the young scapegrace that if he could even translate this epigram of Martial's the authorities would have some grounds for not rusticating him, whereupon the youth, imperiled but undismayed, produced the rendering that will flit forever on the lips of men. Most of us recall Leigh Hunt's "Wise and Wiser," although we are culpably neglecting the author of "An Angel in the House" and "Jenny Kissed Me."

Abel fain would marry Mabel,
Well it's very wise of Abel.
But Mabel won't at all have Abel;
Well it's wiser still of Mabel.

To a few of us there comes back the superscription: "From the French of Tabourot;" but Tabourot was only one of scores who have drawn from our unfailing spring. "Paula, you wish to marry Priscus; I do not wonder; you are wise. Priscus does not wish to marry you; Priscus too is wise." If Martial presents himself so persistently in printed pages, he is also stumbled upon in less likely places. When visiting Ravenna, that "living dream of a city dead," some years ago I found excellent wine included gratis with an excellent dinner, but I was charged extra for water which had to be brought over the hills from Faenza. The circumstance kept haunting me until from the inner cells of my memory I drew forth Martial's experience in the city where wine

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was so plentiful that a cistern was more valuable than a spreading vineyard. "A villainous innkeeper at Ravenna cheated me the other day; I asked for wine mixed with water and the rascal sold me pure wine."

Herewith I have repeated the sin of most readers of Martial, for I have been lured to tarry so long over his more playful song that I must slight his more serious strains.

There is a Catullus-echoing, Horace-recalling Martial, who can sing of friendship and a calm, settled, sweet content in verse not unworthy of his Augustan masters; a Martial who has caught a vision of the *aurea mediocritas* in life's falsehoods of extremes and can picture forth this golden mean for his fellow-men. Where shall we find surpassed his description of the legitimate reward of a well-spent life, familiar to English readers in the adaptation of Pope?

> At length my friend (while time with still career
> Wafts on his gentle wing this eightieth year)
> Sees his past days safe out of Fortune's pow'r,
> Nor dreads approaching Fate's uncertain hour;
> Reviews his life, and in the strict survey,
> Finds not one moment he could wish away,
> Pleas'd with the series of each happy day.
> Such, such a man extends his life's short space,
> And from the goal again renews the race;
> For he lives twice who can at once employ
> The present well, and e'en the past enjoy.

Many poets have warned us against tomorrow, bidding us gather rosebuds while we may, and Martial is of the band; but one of his odes suggests by the faintest undertone that today is a rather solemn little flower withal. This undertone, it seems to me, has never been so daintily reproduced as in the rendering by Goldwin Smith:

> Friend of my heart—and none of all the band
> Has to that name older or better right:
> Julius, thy sixtieth winter is at hand;
> Far spent is now life's day, and near the night.
> Delay not what thou would'st recall too late;
> That which is past, that only call thy own:
> Cares without end and tribulations wait,
> Joy tarrieth not, but scarcely come is flown.
> Then grasp it quickly, firmly to thy heart—
> Though firmly grasped, too oft it slips away:—
> To talk of living is not wisdom's part:
> Tomorrow is too late: live thou today!

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Still more unlike the Martial of popular conception does he appear in an epitaph on a little slave-girl, whose shade he commends to the loving care of the shades of his father and mother. Even the little maiden's name is a caress:

> Ye parents, Fronto and Flocilla here,
> To you I do commend my girl, my dear,
> Lest pale Erotion tremble at the shades,
> And the foul dog of hell's prodigious heads.
> Her age fulfilling just six winters was,
> Had she but known so many days to pass.
> 'Mongst you, old patrons, may she sport and play
> And with her lisping tongue my name oft say.
> May the smooth turf her soft bones hide, and be,
> O earth, as light to her as she to thee! (*Fletcher.*)

Perhaps these three quotations will have given us a glimpse of the anti-Martial in our epigrammatist; at any rate, they may serve to bid us remember that in the poet's complex being salt and spleen, the old *sal* and *fel*, are ofttimes united with serious thought and kindliness of heart. And if we take leave of him by Erotion's grave, we may judge more generously the nature and character of a man whose writings afford only too painful grounds for a judgment that must still be severe, even when justice has been tempered by mercy.

It has been said most happily that the epigram is to literature what the engraved gem is to plastic art. From the Greek hand it issued more dainty, more direct, more simple and sweetly winning; from Martial we receive it sometimes in delicate form, often crisp and vigorous, even at times repulsive, but ever with its lines clear and strong, the work of a master-craftsman. His more delicate epigrams, however, were not the work that won him fame, and they are left too often for the praise of the scholar who clings to beautiful Greek ideals, whereas his scintillating humor and biting wit have been enjoyed by many tastes in all ages since the Roman Empire. Whether the course of the epigram is followed in Italy, France, Germany, or England, the influence of Martial is encountered at every turn. For good or for ill, he molded the epigram, and those who came after him wrought as he had taught them.

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A NEW MASTER OF ENGLISH PROSE AND SOME THEORIES OF VALUE[1]

By Fred B. R. Hellems

In entering upon a consideration of the work of a new English writer, Mr. G. Lowes Dickinson, may we unmask ourselves at once with the frank avowal that we regard him as one of the greatest living masters of English prose, and his views of life as representing the most enlightened and reassuring ideals of a groping and troubled age? If his books are not destined to outlast the pyramids, he will at any rate escape Libitina for many generations, and our literature is appreciably richer for his contributions. Moreover, it is safe to predict that Mr. Dickinson will come into his own not altogether slowly; for, despite the baneful sweep of utilitarianism, we do respond in some measure to the call of the ideal and the beautiful; despite disheartening and deadly failures, we feel that, even in our daily round, "life it is that conquers and death it is that dies." If this is true, our Cambridge essayist may expect from his age a favorable verdict not long deferred; for in his pages the cause of Life and Hope and Beauty is pleaded with the convincing power of an able mind and the winning charm of an almost perfect style.

Before speaking as an advocate, however, he has examined as a judge; and his plea for the things which are better appears as a natural result of an investigation at once reasonable, penetrating, and sympathetic, into the world about him and the various standards of life. In his *Modern Symposium*, for instance, we have as participants a Tory, a Liberal, a conservative, a socialist, an anarchist, a professor, a man of science, a poet, a gentleman of leisure, a member of the Society of Friends, and a man of letters; and in every case the speaker puts his views so well that the most ardent advocate of the particular doctrine or theory could hardly desire a more attractive exposition thereof. To take an extreme case of this clairvoyant sympathy with the views of others, let us write down part of a speech from the lips of Angus MacCarthy, the anarchist:

[1] Reprinted from *The Dial*, Vol. XLI, pp. 226–30 (October 16, 1906), with permission of the editor.

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"Oh!" he broke out, "if I could but get you to see that this whole order under which you live is artificial and unnecessary! But we are befogged by the systems we impose upon our imagination and call science. We have been taught to regard history as a necessary process, until we come to think it must also be a good one; that all that has ever happened ought to have happened just so and no otherwise. And thus we justify everything past and present, however palpably in contradiction with our own intuitions. But these are mere figments of the brain. History, for the most part, believe me, is one gigantic error and crime. It ought to have been other than it was; and we ought to be other than we are. There is no natural and inevitable evolution towards good; no co-operating with the universe, other than by connivance at its crimes. That little house the brain builds to shelter its own weakness must be torn down if we would face the truth and pursue the good. Then we shall see amid what blinding storms of wind and rain, what darkness of elements hostile or indifferent, our road lies across the mountains towards the city of our desire. Then and then only shall we understand the spirit of revolution. That there are things so bad that they can only be burnt up by fire; that there are obstructions so immense that they can only be exploded by dynamite; that the work of destruction is a necessary preliminary to the work of creation, for it is the destruction of the prison walls wherein the spirit is confined; and that in that work the spirit itself is the only agent, unhelped by powers of nature or powers of a world beyond—that is the creed—no, I will not say the creed, that is the insight and vision by which we of the Revolution live. By that I believe we shall triumph. But whether we triumph or no, our life itself is a victory, for it is a life lived in the spirit. To shatter material bonds that we may bind the closer the bonds of the soul, to slough dead husks that we may liberate living forms, to abolish institutions that we may evoke energies, to put off the material and put on the spiritual body, that, whether we fight with the tongue or the sword, is the inspiration of our movement, that, and that only, is the true and inner meaning of anarchy."

How many of us ever dreamed of anarchy voiced in words like these? And yet MacCarthy is possibly the speaker with whom the master of the banquet (who is, of course, Mr. Dickinson *in propria persona*) has least sympathy. In our own experience, each new page left us more convinced that we were dealing with a man who had seen the whole in its parts and the parts in the whole, who had kept his feet upon solid earth while his eyes were turned to the signals from the heights, so that with each step we found ourselves more willing to follow his upward leadership. And the heights to which he leads us, or rather to which he invites us to climb by his side, are always beautiful, albeit occasionally dimly descried by myopic eyes or not quite to be scaled by the wayfaring man.

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The greatest height, indeed, he himself never confidently achieves; for he concludes his dialogue on *The Meaning of Good*, a search for reality, with a glorious allegorical vision, and waking from it says:

> So that I have had to go on ever since with the knowledge I then acquired, that whatever Reality may ultimately be, it is in the life of the affections, with all its confused tangle of loves and hates, attractions, repulsions, and, worst of all, indifferences, it is in this intricate commerce of souls that we may come nearest to apprehending what perhaps we shall never wholly apprehend, but the quest of which alone, as I believe, gives any significance to life, and makes it a thing which a wise and brave man will be able to persuade himself it is right to endure.

Accordingly, with his great Greek master and not a few others from the kings of thought, he seems to end his climbing in a cloud; but it is a cloud lightened by hope rather than darkened by despair, and enforces the thought that "they see not clearliest who see all things clear." To other peaks, however, he leads us, where the vista is as clear as it is beautiful, and even the paths through the lower-lying valleys have their own appropriate charm.

The themes treated by Mr. Dickinson are not new, nor does the form of his treatment offer any innovation. Religion, the meaning of good, literature, art in general—in short, the things of the mind and the spirit—are treated in essay or dialogue or letter, and we do not need to be reminded that these forms were brought to artistic perfection in olden days. The fact is merely that, having chosen immortal topics, he has treated them with not less largeness of outlook than clearness of inward vision, and has exhibited unerring judgment and unfailing skill in adapting his form to his matter. Thus he is manifestly right in his feeling that a discussion of the meaning of good belongs "to the sphere of right opinion and perception, rather than to that of logic and demonstration, and seems therefore to be properly approached in the tentative spirit favored by the Dialogue form," nor can we refuse to agree that this literary form comes closest to the interchange of actual conversation, "from which we gain our best lights on such a subject." The same unerring instinct or judgment leads him to put his contrast between eastern and western ideals (*Letters from a Chinese Official*) in the form of letters from an enlightened Chinaman who has resided long in England without losing his affection for his native land and all that it represents. Howbeit, other

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men are writing on these same eternal subjects without failing to choose appropriate garb therefor, so that we are driven to the provocative statement that our author treats the themes with greater power than most of his contemporaries and makes the appropriate garb more beautiful. In the nature of things, it is impossible to justify such a statement by fragmentary excerpts and curtailed arguments; but we should be thoroughly surprised if many intelligent readers should rise from a perusal of Mr. Dickinson's works with any strong dissent from the judgment we have submitted.

Recognizing freely this impossibility, we must still face the duty of giving at least an adumbration of our author's position with reference to some of the central themes of life, and we may as well fail on religion as on any other subject. His attitude, then, in marred and imperfect form, is about this:

I. Religious truth is attainable, if at all, only by the method of science. There is no "revelation" in the accepted usage of the term.

II. Religion is a "reaction of the imagination upon the world as we conceive it in the light at once of truth and of the ideal," which amounts to saying that religion is a certain attitude toward life, willing to recognize the helpfulness of ideas not based on definitely ascertained truth.

III. If this definition is too wide, we should consider that there is something between hope and faith, but nearer to the latter and called by its name—an attitude of "active expectancy, the attitude of a man who, while candidly recognizing that he does not know, and faithfully pursuing or awaiting knowledge, and ready to accept it when it comes, yet centers meantime his emotional and therefore his practical life about a possibility which he selects because of its value or its desirability." In other words, for practically all men there must be a "volitional assumption," not based upon knowledge, as to the worth-whileness of existence, if life is to be most noble and most fruitful.

The objections to such a view were too manifest to escape our thinker, and he has stated them fairly, thereby relieving us from enlarging upon them; and we may merely point out that this is the faith, not of an ecclesiastic, but of a platonizing philosopher. And yet, with the more recent work of our author before him, Mr. Gilbert Chesterton could not

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have written his flamboyant if futile chapter on Neo-Paganism. Mr. Dickinson does not attempt "merely to revive the pagan idea of a simple and rational self-completion." Rather, he looks for the tide of noblest spiritual progress where the lustrous and rapturous river from the pagan springs of Love and Beauty and Wisdom meet the more sober stream of ideals from the fountain of Christianity. The last speaker in the *Symposium*, who "expressed himself in a style too intellectual for lovers of poetry, too metaphorical for lovers of philosophy," voices the thought in this glowing deliverance uttered in the glamor of the dawn:

It is only in the soil of Paganism that Christianity can come to maturity. And Faith, Hope, Charity, are but seeds of themselves till they fall into the womb of Wisdom, Beauty, and Love. Olympus lies before us, the snow-capped mountain. Let us climb it, together, if you will, not some on the corpses of the rest; but climb at least, not fester and swarm on rich meadows of equality. We are not for the valley, nor for the forest or the pastures. If we be brothers, yet we are brothers in a quest, needing our foremost to lead. Aphrodite, Apollo, Athene, are before us, not behind. Majestic forms, they gleam among the snows. March, then, men in Man!

If we add this half-mystic flight to the formal statement essayed above, we shall probably draw as near to the inner sanctum as our philosopher-priest cares to allow the profane to approach without longer service; and even those who cannot accept his religion and worship in his spirit must feel their hearts quickened and their lives enlarged from visiting the courts of the temple by his side.

From his views on art and literature there will be fewer dissenters. Where can we find anything on letters more exquisite than the sentiments of our Chinese official?

Our poets and literary men have taught their successors, for long generations, to look for good, not in wealth, not in power, not in miscellaneous activity, but in a trained, a choice, an exquisite appreciation of the most simple and universal relations of life. To feel, and in order to feel to express, or at least to understand the expression of all that is lovely in Nature, of all that is poignant and sensitive in man, is to us in itself a sufficient end. A rose in a moonlit garden, the shadow of trees on the turf, almond bloom, scent of pine, the wine cup and the guitar; these and the pathos of life and death, the long embrace, the hand stretched out in vain, the moment that glides forever away, with its freight of music and light, into the shadow and hush of the haunted past, all that we have, all that eludes us, a bird on the wing, a perfume

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escaped on the gale—to all these things we are trained to respond, and the response is what we call Literature.

Hardly less effective is the treatment of art in the dialogue on *The Meaning of Good*, a treatment almost as perfect in its way as the well-known stanzas quoted from the "Ode to a Grecian Urn" in the course of the discussion, to which we can only allude. Again, in the third or central chapter of the essays on religion we may find the following thoughts on the contribution of architecture to religion:

> It has raised the material habitation of the Divine, and in doing so has reflected, I think, by a perhaps unconscious symbolism, the forms in which that Divine has been conceived. Surely, at least, one might question whether the difference between a classical temple and a Gothic church is to be attributed only to a difference of climate, or of technical skill and tradition. It would be a curiously happy chance, if it were merely chance, that made the house destined for the abode of one of the bright Olympians a palace of gleaming marble set on a hill by the sea, perfect in form, brilliant in color, a jewel to reflect the sun and the sky, a harp for the winds to play upon, an incarnation of the spirit of the open air, of the daylight and of the blue heaven; while, for the mysterious Jehovah and the God Man His Son, there rose into gray and weeping skies huge emblems of the cross, crowned with towers aspiring to a heaven unexplored, and arched over huge spaces where the eye is lost in the gloom, where form is dissolved in vagueness, and the white light of day, rejected in its purity, is permitted to pass only upon condition that it depicts in somber colors the pageant of the life of the soul. That architecture has, whether by chance or no, a symbolic value, as well as one purely and simply aesthetic, will not, I think, be disputed by those who are sensitive to such impressions; and, so regarded, architecture has been, and might be again, one of the chief expressions of religion.

One recognizes throughout the doctrine of Goethe that art rests fundamentally on a kind of religious sense, and therefore unites so readily with religion; but one recognizes also an insistence with Morris on the possibilities of an intimacy and tenderness of art that shall allow it to become more easily an integral part of our daily lives.

Foregoing the pleasure of commenting on other phases of Mr. Dickinson's works, we must content ourselves with a brief mention of his attitude to our own land. To the present reviewer he seems to be absolutely fair and candid, albeit his candor is of the unflinching sort. Far too many of his readers both in America and in England will be prone to find his final verdict in the speech of Arthur Ellis, the traveled journalist,

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and inasmuch as that contributor's arraignment of our "worship of acceleration" and our "doctrine of progress" is not less quotable than powerful, the reviewers and others will be sure to keep it before the public. Herein, however, we should be erring grievously; for Ellis, although the giver of the intellectual feast regards his attack as formidable, sits down amid a "hubbub of laughter, approval, and protest, confusedly mixed;" and a little later Sir John Harington, a gentleman of leisure interested mainly in art, takes up the journalist's diatribe with the expression of a strong hope that the better age for artistic interests may after all dawn in America. But from neither journalist nor artist should we accept our essayist's own views, which may be best understood from his deliberate words in the introduction to the American edition of the *Letters from a Chinese Official*:

> For it is impossible not to recognize that the destinies of Europe are closely bound up with those of this country; and that what is at stake in the development of the American Republic is nothing less than the success or failure of Western civilization. Endowed, above all the nations of the world, with intelligence, energy, and force, unhampered by the splendid ruins of a past which, however great, does but encumber, in the Old World, with fears, hesitations, and regrets, the difficult march to the promised land of the future, combining the magnificent enthusiasm of youth with the wariness of maturer years, and animated by a confidence almost religious in their own destiny, the American people are called upon, it would seem, to determine, in a pre-eminent degree, the form that is to be assumed by the society of the future. Upon them hangs the fate of the Western world.

One who did not know many sides of Cambridge would hardly be prepared to hear this voice from her academic shades; but, having heard it, one feels no serious rebellion against this other assertion about America:

> For a century past she has drawn to herself, by an irresistible attraction, the boldest, the most masterful, the most practically intelligent of the spirits of Europe; just as, by the same law, she has repelled the sensitive, the contemplative, and the devout. Unconsciously, by the mere fact of her existence, she has sifted the nations; the children of the Spirit have slipped through the iron net of her destinies, but the children of the World she has gathered into her granaries. She has thus become, in a sense peculiar and unique, the type and exemplar of the Western world. Over her unencumbered plains the Genius of Industry ranges unchallenged, naked, unashamed.

With the spirit of these words from the aged university beside the Cam, who shall quarrel? Nay, is it not the best evidence of our strides toward

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healthful manhood that we have no longer the childish and neuralgic sensitiveness we manifested under the searching criticism of a gifted son from the sister-university on the Isis? Such critics as Matthew Arnold and Mr. Dickinson must help us to receive "the spirit of the world that created manners, laws, religion, and art—which is hovering even now at our gates in quest of a new and more perfect incarnation." Well will it be for us, and for the world at large, if this incarnation is achieved while our nation is yet young and time itself has not grown old.

For a consideration of Mr. Dickinson's style *per se* we have little space remaining. However, the foregoing quotations have spoken for themselves, and we may limit our excerpts to one example of simple description, perhaps the most difficult form of artistically effective prose. It is introduced by the author in partial answer to the query as to what manner of men these Orientals are.

Far away in the East, under sunshine such as you never saw (for even such light as you have you stain and infect with sooty smoke), on the shore of a broad river, stands the house where I was born. It is one among thousands; but every one stands in its own garden, simply painted in white or gray, modest, cheerful, and clean. For many miles along the valley, one after the other, they lift their blue or red-tiled roof out of a sea of green; while here and there glitters out over a clump of trees the gold enamel of some tall pagoda. The river, crossed by frequent bridges and crowded with barges and junks, bears on its clear stream the traffic of thriving village-markets. For prosperous peasants people all the district, owning and tilling the fields their fathers owned and tilled before them. The soil on which they work, they may say, they and their ancestors have made. For see! almost to the summit what once were barren hills are waving green with cotton and rice, sugar, oranges, and tea. Water drawn from the river-bed girdles the slopes with silver; and falling from channel to channel in a thousand bright cascades, plashing in cisterns, chuckling in pipes, soaking and oozing in the soil, distributes freely to all alike fertility, verdure, and life. Hour after hour you may traverse, by tortuous paths, over tiny bridges, the works of the generations who have passed, the labors of their children of today; till you reach the point where man succumbs and Nature has her way, covering the highest crags with a mantle of azure and gold and rose, gardenia, clematis, azalia, growing luxuriantly wild. How often here have I sat for hours in a silence so intense that, as one of our poets has said, "you may hear the shadows of the trees rustling on the ground;" a silence broken only now and again from far below by voices of laborers calling across the water-courses, or, at evening or dawn, by the sound of gongs summoning to worship from the temples in the valley. Such silence! Such sounds!

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Such perfume! Such color! The senses respond to their objects; they grow exquisite to a degree you cannot well conceive in your northern climate; and beauty pressing in from without molds the spirit and mind insensibly to harmony with herself.

To borrow from an old critic, anybody could write that except those who have tried. But with our excerpts before us we feel most keenly that they have utterly failed to convey any idea of the charm of the complete works, and we fear we should feel the same even in the presence of the better selection that any of our readers could have made.

Of the various works we have mentioned, the *Modern Symposium* seems to us the finest, although the others in their own way achieve an excellence that need not fear comparison and will doubtless be preferred by not a few readers. The scene of the masterpiece is laid on a Sussex terrace in the month of June, and the dialogue, or rather the series of monologues, lasts from the late evening light to the dawn; but the reader feels that there was never a flagging moment from the opening speech of the comfortably discouraged Tory speaking appropriately after a comfortable dinner, to the semi-oracular utterance of the poet-philosopher speaking with even greater appropriateness while the glamor of dawn passed into the clear light of morning. Every character is made to speak in the language and style one feels inevitable. Indeed, one could easily transfer the speakers from the printed page to their accustomed walks of life, and in some cases could assign a definite name. There is not a faulty word at any turn, nor the least suspicion of striving for effect. The very transitions from character to character seem to bind the parts together and disappear in their service. Seldom has art been concealed more skilfully than in these pages, where Mr. Dickinson is most himself. In many of his other writings one can put a hand on this passage or that, and murmur Goethe, Landor, Pater; but in this work one feels strongly only the great master of them all, who wrote the parent *Symposium*. And perhaps one could pay no greater tribute to the contemporary *Symposium* than to say it is not unworthy to stand beside the Platonic original. Of course, it falls far short of the older dialogue in imaginative range—which is merely saying that it does not attain the unattainable and ought not to be compared with the incomparable, for Plato's *Symposium* and *Phædrus* still occupy a niche by

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themselves in the hall of fame of imaginative prose. In one respect, however, the modern product is, perhaps, not inferior, for it does keep a shade more closely in touch with our human hopes and needs. From the master's banquet one rises amidst the fumes of the strong wine of almost demoniacal possession, such as Plato himself describes in his doctrine of enthusiasm, stimulating, exhilarating, sweeping us to the skies of fancy. At the disciple's feast is still strong wine; but it is the wine of helpful, aspiring reason, glorifying and uplifting, preparing us to face "without excitement or elation the duties of the new day."

It would be easy to select the writers who have influenced Mr. Dickinson most, but it must suffice to recall that his reading represents the curriculum of a Fellow of a Cambridge college with a cultured taste for literature and philosophy. We must point out, however, that the Greek classics have occupied the fundamental position in molding his style and thought, and we regard it as a thrice happy accident that we were introduced to him through his *Greek View of Life*,[1] for it is the natural portal. With modern literature he is only less familiar; and American readers will even find manifest traces of Walt Whitman. In every case, however, the traceable influence is entirely free from any suggestion of plagiarism, and we have no mere collection of jewels, but a new and finished product. Even the metrical quotations inspire the feeling that they should have been written for exactly the place they occupy. Over all of his writing is shed just enough of the *poeticus color* to make his style charming as well as effective. Indeed, for those of us who see in English prose one of the highest forms of art—all the more important because it can ultimately be made to appeal to a practically unlimited constituency—Mr. Dickinson at his best fulfils Sainte-Beuve's critical demand upon poetry—*il fait battre le cœur*.

[1] Reviewed by the present writer under the caption, "The Old Untroubled Pagan World," in *The Dial* for March 16, 1906.

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SHAKESPEARE AND PSYCHOGNOSIS

ESSAY III. MAJOR CHARACTERS OF "THE TEMPEST" [*Concluded*] [1]

By Melanchthon F. Libby

Miranda: Ideal Feminine Type

Sycorax, Claribel, Ceres, and Juno, and the sea-nymphs, are female characters interesting to the student of *The Tempest*, but strictly speaking Miranda is the only female character dramatically portrayed. Of Miranda's mother almost no mention is made, though in the relation of his downfall it is remarkable that Prospero says nothing of his duchess, since the girl should naturally be curious concerning her lost parent. The austerity of Prospero is emphasized by the fact that Miranda has been twelve years upon the island without having learned anything of her origin. Her remembrance of the women that once tended her prepares her to believe in her high birth, still the tale affects her like an improbable romance. If the loss of his wife, before his child was three years old, was associated with his overthrow, it must have added to his sense of injury, but even in the fifth act there is no mention of her. The couplet

> "Thy mother was a piece of virtue, and
> She said thou wast my daughter,"

records all that we know of the mother of Miranda. Miranda appears in four scenes—the second, fifth, eighth, and ninth.

The whole burden of pity, caused by the sight of the vessel dashed to pieces, with its freight of noble creatures, as she generously and romantically conceives, is transferred to the interest of Ferdinand the moment she meets him. Pity is converted by the chemistry of romance into love of the sufferer. The immense compassion and sympathy revealed in the earliest speeches of Miranda are the natural overflow of a full and intense heart not yet engaged in a romantic attachment.

While her father tells her the story of her life, her pride of birth is roused, but much more her feelings of pity for her father and his cares. She listens with the intense interest of a girl naturally eager for romance and charmed to find her own story full of it. The gushing sentiment with which she greets every part of the story, shown in her intense little speeches, "O, good sir, I do!" "O, the heavens," "Alack for pity," "Alack, what trouble was I then to you!" "Would I might but ever see that man!" indicates a disposition that must have been soothing to Prospero, deprived of the applause and love which he had a right to expect as the social reward

[1] The other essays on the characters of *The Tempest* appeared in the *University of Colorado Studies*, Vol. III, p. 63 and p. 229. This series will be followed by essays dealing with the types of human situations. A third series will include a discussion of the whole problem of *The Tempest* and Shakespeare's psychognosis.

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of his goodness, learning, and patriotism; but which he missed in his banishment. Miranda's sentiment is of the true breed, not the kind that leads to no corresponding action, like that of Jacques weeping for the deer and neglecting to assist the starving Adam; but the kind that needed only occasion to be realized as practical love. All the wealth of sentiment occasioned by the sight of the shipwreck and raised and intensified by the exciting story of Prospero's earlier tempest, is a preparation for her meeting with the young prince. She falls asleep in spite of her excited feelings, as though composed to rest by her father's magic. Her visit to Caliban, in which she lashes him with scorn and contempt, intervenes between her waking and the fateful meeting. Her attitude toward Caliban is one of sincere disgust. Her opinions in general coincide with those of Prospero, but she is not endowed with his masculine and practical qualities, she is not "any god of power," and she is emotional and inexperienced.

The scene makes it clear that she has been endowed with an ideal feminine character by heredity, and that she has grown up in an atmosphere of natural freedom, kindness, and learning. While she is governed by right principles, she holds these rather as likes and dislikes than as rules of conduct.

It is with much art that Prospero says, "The gallant that thou seest was in the wreck." Miranda's conduct in this scene with Ferdinand reminds one of a criticism of the pedimental statues of the Parthenon; they seem to have been studied from natural models, but such as we never have the good fortune to see. Miranda solves, or rather is, the concrete solution of the question of the freedom and equality of women. The boldness of perfect sensibility and exquisite refinement cannot be out of keeping with the ideal feminine type. Artificial modesty is essential to a convention where the feelings are more or less unnatural. The best rules approach the best impulses as guides to graceful and appropriate conduct. It is prudent to rely upon the best rules. But where nature gives deportment with refinement, what need is there of a convention? Those who might retort that Sycorax and Caliban are perfectly natural have yet to understand the meaning of the progressive refinement of instinct. Perfect human grace is nature's own seal of refinement with balance; but there is the animal grace of the tiger, and the spiritual grace of a fairy. Miranda is a woman, partly of earth and partly of spirit, and on her own level of progress she is well balanced and instinctive. When the social forces are ill balanced in a character, the conventional restraints give artificial grace; but Miranda is a law unto herself. Perdita growing to womanhood among peasants is yet a queen, and equal in manners to Prince Florizel. Guiderius and Arviragus, without conventional knowledge, are princely; "'tis wonder that an invisible instinct should frame them to royalty unlearned, honour untaught, civility not seen from other."

Miranda not only shows plainly enough her sudden love for Ferdinand, but pleads with her father for him in a manner rather astonishing from the standpoint of Elizabethan usage. Prospero approves of all this. But he acts harshly to Ferdinand. He wishes the thought of Miranda to be associated, not only with Ferdinand's

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happiness, but with his grief, trouble, labor, endurance, all the varied emotions of life, until she is a part of his habit of thought; until, in a word, every work becomes a labor of love, and his energies are radiated into high activities through her invaluable influence in idealizing him, and herself in him. Before the scene closes she is consoling him in his weakness and discouragement, and thereby associating herself with his strongest emotions.

Scientific criticism must recognize, however it fails duly to appreciate, the massive romantic feeling of this scene. To fail in this is to throw the play quite out of joint. Yet this is precisely the difficulty in estimating this play; to preserve the simplicity of a youthful reader of romance, and to estimate the subtle motives of Prospero; to be synthetic and analytic at once.

The scene reveals Miranda as the daughter of Prospero. The father is a concrete harmonized paradox of the most contrasted qualities—subtlety and simplicity, strength and sensitiveness, social power and love of solitude. The daughter is like him in the feminine sphere—learned but natural, sweet but scathing, infinitely modest, absolutely bold for her rights.

It is in this graceful sublation of the most poignantly contrasted qualities that her character consists. The feminine gentleness of Miranda, and her youth, must not blind the critic to her greatness; she is naïve, but great, and this appears chiefly in her rightness of affection, a strong naturalness guaranteeing lesser goods. She is not bold and modest, or bold in spite of her modesty; her boldness is her modesty. It is not in suffering paradox, but in the vital harmonizing of paradox into a higher grace, that her superior charm consists. Her selfishness is good for the world, yet it is without afterthought. She is the daughter of Prospero, by birth and education, and like him she has that sympathy which identifies self with the social world. She has self-knowledge without self-consciousness, sympathy compatible with dignity and independence; Prospero's wisdom, vast, minute, analytic, is in Miranda a vital instinct, equally sure but smoother; the highest art struck into natural simplicity. She is a return to nature from the extreme refinement of a well-balanced culture.

The fifth scene reveals the lovers in their perfection:

> "The mistress which I serve quickens what's dead
> And makes my labours pleasures."

Labor not for love is labor lost; a futile fever of exertion. Labor performed for affection is the sole cause of progress. All social affections center in and radiate from romantic feeling. This is the poetic philosophy. Miranda's character is massed rather than analyzed. After this scene she speaks only five times, and her speeches are brief and of little importance. Her life and character are summed up in the idea of romantic love used as an encouragement to labor. The sympathies displayed in the earlier scenes, the hatred of the backward Caliban, the boldness in welcoming the prince, the words of support, comfort, consolation which she tenderly

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lavishes upon Ferdinand, the innocent preference of her lover's company to strict filial obedience, all indicate the one induction, that Miranda is instinctively pervaded by the feminine idea of rewarding danger, exertion, endurance, all means of progress, by sympathy and love. It does not follow that sympathy may not show in exertion, intelligence, activity. She offers to bear the logs herself; but in its ideal stage her character is sympathetic rather than active, and we confidently regard her as a type of feminine romance and chivalry.

> "I am your wife, if you will marry me;
> If not I'll die your maid."

Devotion, constancy, romance, childlike trust and admiration, and childlike boldness and innocence, are some abstract terms corresponding to concrete facts set forth concerning the heroine. The scene suggests that the more willing Miranda is to assist in Ferdinand's log-bearing, the more able Ferdinand is to support the toil for himself and the more unwilling to accept her proffered aid.

In the eighth scene Miranda shows her quick knowledge of her father's moods; in spite of her new love and of her pride in the beautiful masque, she shows her solicitude touchingly.

In the last scene Alonzo discovers his long-sought Ferdinand playing chess with Miranda in the cell. The lovers are playing and gaily quarreling, enjoying their amusement better for the reflection that the logs are piled. Nothing can ruffle their tempers; Ferdinand's greatest right is to yield his rights to Miranda, and Miranda says:

> "Yes, for a score of kingdoms you should wrangle,
> And I should call it fair play."

This, says the ironical scientist, is the usual love-story tone; the central theme of Shakespeare's deepest play can hardly lie in this.

Miranda's last speech provokes Prospero's only cynical, playfully cynical, remark:

> "O, wonder!
> How many goodly creatures are there here!
> How beauteous mankind is! O, brave new world,
> That has such people in it!"
> " 'Tis new to thee!"

remarks Prospero, sententiously.

Miranda is a broad type, not loaded with details of character, yet rich in force and brightness, of the ideal feminine character at the age of selection; she appears in every love-story from the earliest mythology to the present novel.

Ferdinand: Adolescent Hero of Romance

In the shipwreck scene Ferdinand is mentioned as at prayers with his father, King Alonzo of Naples.

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In the second scene he appears, following Ariel, or rather Ariel's music. He attributes the music to supernatural causes. As he sat weeping the loss of the king the music crept by him upon the waters. "This is no mortal business, nor no sound that the earth owes." In this mood transported by heavenly music, he sees and loves Miranda—"Most sure, the goddess on whom these airs attend." He declares his wonder and admiration immediately. He speaks of himself with pride as one accustomed in the world to receive homage on account of his rank as well as his merit. Prospero, assuming his harshest manner, curbs the prince's pride somewhat sneeringly. Ferdinand manfully resists the magician's severity, but is charmed into helplessness.

"Put thy sword up, traitor;
Who mak'st a show, but dar'st not strike, thy conscience
Is so possessed with guilt."

"Thy nerves are in their infancy again,
And have no vigour in them."

To these harsh judgments Ferdinand replies,

"So they are;
My spirits, as in a dream, are all bound up,
My father's loss, the weakness which I feel,
The wreck of all my friends, or this man's threats,
To whom I am subdued, are but light to me,
Might I but through my prison once a day
Behold this maid. All corners else o' the earth
Let liberty make use of; space enough
Have I in such a prison."

It is the old story of the imprisoned knight dreading the captivity that prevents him from the daily sight of the fair lady. Our first impressions of Ferdinand are of a young man depressed by misfortune, susceptible to music and beauty. Under the spell which binds up his nerves he preserves his courage and self-respect and undiminished faith in the consoling power of his sudden attachment to Miranda. Throughout his speeches there is a certain pride, partly consisting of manly confidence and partly of pride of place and worldly prospects:

"O! if a virgin,
And your affection not gone forth, I'll make you
The Queen of Naples."

There is a good share of manly independence in the tone of this.

Ferdinand's fate is a common topic among the king and his followers. Antonio's conspiracy rests on the assumption that he is drowned. "Will you grant with me

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that Ferdinand is drown'd?" Sebastian replies: "He's gone." Gonzalo alone had faith in the future of Ferdinand.

In scene 5 Ferdinand's speech on love and labor shows his real depth of thought and feeling. His pride is not vain superciliousness, or he would be enraged by the crabbed injunctions of the father. The noble humility with which he waives his rank and performs labors so deeply offensive to him suggests that in true love alone can be found the basis of the unreasoning reasonableness by which man relinquishes his rights and becomes what scientists call a moral being: "for your sake am I this patient log-man." This feeling conserved and irradiated offers a basis for the poetic ethics; but Ferdinand's love is not to be confused with a barbarous attachment, a selfish bargain, or a conventional contract. His profession of attachment, though ardent, shows that he is spiritual as well as sensual: "I love, prize, honour you." The scene calls for no comment, it is sufficiently elevated and spiritual to guarantee constancy under fairly favorable conditions.

In the eighth scene Ferdinand is accepted as a son by Prospero. He takes the injunctions of Prospero well: "The strongest suggestion our worser genius can, shall never melt mine honour into lust." This perception and frank discussion of the conflicting spirits of honor and sensuality show the clear head and character of Ferdinand. Like other lovers, he is not marked by brilliant actions or original speeches. Bassanio's splendid, generous character is shown by the love he commands in all who know him. And so Ferdinand is to be accepted as a fitting hero for what he is to Prospero and Miranda, rather than for what he does or says.

In the ninth scene he appears as the happy lover, resting from his labors. His final speech in its frank, vigorous but respectful manliness sums up one's impressions of the hero of *The Tempest*.

"Sir, she is mortal:
But by immortal Providence she's mine;
I chose her when I could not ask my father
For his advice, nor thought I had one. She
Is daughter to this famous Duke of Milan,
Of whom so often I have heard renown,
But never saw before: of whom I have
Received a second life: and second father
This lady makes him to me."

To the romantic reader Alonso's reply redeems all his faults; with simple dignity he answers this impetuous eloquence:

"I am hers;
But oh how oddly will it sound that I
Must ask my child forgiveness."

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Ferdinand and Miranda are types of lovers of the best class, in whom a degree of natural warmth and passion is blended harmoniously with the finest spiritual singleness. Ferdinand is more selfish and strong than Miranda, Miranda more clinging and sympathetic than her lover. They stand on the same plane of civilization as Antonio and Gonzalo; but, while the latter pair illustrate the extreme types of selfishness and unselfishness, and are divided by the whole sweep of social differences, the lovers illustrate that mutual give-and-take which gives them a kind of unity in their relation or, as the poetic philosopher has said, "Reason in itself confounded, saw division grow together;" and, in another place, "Number there in love was slain;" and yet again, "Property was there appalled, that the self was not the same."

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THE MATHEMATICS OF LIFE INSURANCE[1]

By S. Epsteen

§ 1. Introduction

Just as everybody eats bread without knowing its chemical composition, so everybody uses insurance without understanding its nature. Insurance is a guarantee of indemnity; its object is to replace money or other property that is lost. The theory of the system is this: Many people who are subject to a common danger of financial loss agree to pool their expected losses by providing in advance, by general contribution, a fund from which those who actually suffer loss may be indemnified.

If a man insures his house for exactly what it is worth, say $5,000, and pays $50 per year, and the house burns, he receives $5,000. Thus he is in almost as good a position financially as before, having lost only the amount of the premium—$50. In this respect, however, he is in exactly the same position as every other man insured for a like amount on equally valuable property and at the same time—each of them has lost exactly $50 and each has $5,000 less $50. The fact that one man has $5,000 in cash and the others each have $5,000 worth of house does not affect the comparison. It is thus seen that insurance is a co-operative scheme whereby each member of the community pockets a small loss in place of one member sustaining a severe loss. The insurance company acts as an intermediary in distributing this loss.

Life insurance does not insure life in quite the same sense that fire insurance insures a house or marine insurance a ship. Should the house burn or the ship sink the insurance company can (and sometimes does) substitute another for it. But one cannot substitute a new life for the one terminated. In life insurance one insures the product of the effort which a man exerts when alive (and which he cannot exert when dead), and not life itself.

[1] Read before the University of Colorado Scientific Society, January 29, 1906. In preparing § 1 I have followed Campbell's *Insurance and Crime*, Introduction, and in § 3, *Educational Leaflets* No. 2, issued by the Mutual Life Insurance Co. of New York.

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§ 2. The Mortality Table

In this country premiums are computed on the basis of the American Experience Mortality Table (see p. 37). The table begins, not with birth, but with the age of ten, for two reasons. First, the law of infant death-rate is unknown, and, secondly, it is illegal in most states (Colorado included) to insure children under that age. It was found necessary to pass this law on account of the large number of children who were put to death for the insurance money.

The fact that out of 81,822 men, age 35, 732 died, is no proof, theoretically, that 732 will die out of the next 81,822 of the same age. Experience shows, however, that the number will be astonishingly close to this. You will see later that in the computations based on this table, the theoretical net premiums are increased by the so-called loading to allow for an unexpected excess in mortality. As a matter of fact, the above table is very conservative, and the death-rate is not so high as there indicated. Especially during the first five or six years, before the influence of the selection by the preliminary medical examination has disappeared, the actual mortality is a rather small percentage of the tabular mortality rate.

§ 3. The Net Single Premium

To begin with, it will be shown, by a typical example, how life insurance premiums are computed. The solution is outlined for the age 35, but it will be apparent that the method is perfectly general and can be employed to find the premium at any other age. For the sake of illustration, the policy is supposed for $1,000; of course, a policy for $5,000 would cost five times as much, one for $10,000 would cost ten times as much. So that the method about to be given (which is, at bottom, the one actually employed in the construction of the tables for the insurance companies) serves to determine the premium at any age and for any amount.

Let us suppose that a life-insurance company is organized, consisting of 81,822 persons each 35 years of age and each insured for $1,000 payable at death. For convenience we take the figures 81,822 as our total membership that being the number of persons still living at age as given in the mortality table of § 2. It is also for convenience—to make

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TABLE I

AMERICAN TABLE OF MORTALITY

Age	Number Living	Deaths Each Year	Death-Rate per 1,000	Age	Number Living	Deaths Each Year	Death-Rate per 1,000
10	100,000	749	7.49	53	66,797	1,091	16.33
11	99,251	746	7.52	54	65,706	1,143	17.40
12	98,505	743	7.54	55	64,563	1,199	18.57
13	97,762	740	7.57	56	63,364	1,260	19.88
14	97,022	737	7.60	57	62,104	1,325	21.33
15	96,285	735	7.63	58	60,779	1,394	22.94
16	95,550	732	7.66	59	59,385	1,468	24.72
17	94,818	729	7.69	60	57,917	1,546	26.69
18	94,089	727	7.73	61	56,371	1,628	28.88
19	93,362	725	7.76	62	54,743	1,713	31.29
20	92,637	723	7.80	63	53,030	1,800	33.94
21	91,914	722	7.85	64	51,230	1,889	36.87
22	91,192	721	7.91	65	49,341	1,980	40.13
23	90,471	720	7.96	66	47,361	2,070	43.71
24	89,751	719	8.01	67	45,291	2,158	47.65
25	89,032	718	8.06	68	43,133	2,243	52.00
26	88,314	718	8.13	69	40,890	2,321	56.76
27	87,569	718	8.20	70	38,569	2,391	61.99
28	86,878	718	8.26	71	36,178	2,448	67.66
29	86,160	719	8.34	72	33,730	2,487	73.78
30	85,441	720	8.43	73	31,243	2,505	80.18
31	84,721	721	8.51	74	28,738	2,501	87.03
32	84,000	723	8.61	75	26,237	2,476	94.37
33	83,277	726	8.72	76	23,761	2,431	102.31
34	82,551	729	8.83	77	21,330	2,369	111.06
35	81,822	732	8.95	78	18,961	2,291	120.83
36	81,090	737	9.09	79	16,670	2,196	131.73
37	80,353	742	9.23	80	14,474	2,091	144.47
38	79,611	749	9.41	81	12,383	1,964	158.60
39	78,862	756	9.59	82	10,419	1,816	174.30
40	78,106	765	9.79	83	8,603	1,648	191.56
41	77,341	774	10.01	84	6,955	1,470	211.36
42	76,567	785	10.25	85	5,485	1,292	235.55
43	75,782	797	10.52	86	4,193	1,114	265.68
44	74,985	812	10.83	87	3,079	933	303.02
45	74,173	828	11.16	88	2,146	744	346.69
46	73,345	848	11.56	89	1,402	555	395.86
47	72,497	870	12.00	90	847	385	454.54
48	71,627	896	12.51	91	462	246	532.47
49	70,731	927	13.11	92	216	137	634.26
50	69,804	962	13.78	93	79	58	734.18
51	68,842	1,001	14.54	94	21	18	857.14
52	67,841	1,044	15.39	95	3	3	1000.00

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the problem as simple as possible—that we assume that each member of our company will maintain his membership during his entire lifetime, and that no new members will be added after the date of organization.

The 81,822 members of our company will all die within the next 61 years, making a total ultimately to be paid of $81,822,000. This enormous sum is to come entirely from the premiums that are to be paid by the members and the interest which these premiums will earn. The problem is to determine how large a premium each member must pay in order to create a fund sufficient for this purpose.

It is not known how long any particular member of our company will live. The amount that each member should pay, therefore, cannot be determined by means of a computation based on a single life. But if it is not known how long any one individual will live, it is known how long certain groups of members will live. For example, the mortality table shows at age 35 that 732 members will live only 1 year, 746, 2 years; 812 will live 10 years to age 45; 1,143, 20 years to age 55; and that 3 will live 61 years to age 96. The computations must therefore be based upon the aggregate number of lives, the length of time the members will live as a body, as shown in case of these several groups. Although it is customary to pay immediately upon proof of death, it is here assumed, for the sake of simplicity, that payment is made at the end of the year in which the deaths occur.

Since 732 die the first year, the company will have to pay out $732,000 at the end of the year. It is not necessary, however, to have the full sum on hand at the beginning of the year. The present worth of $732,000 is $707,258.40; that is to say, if one invests $707,258.40 at 3½ per cent. interest, it will amount to $732,000 in one year. Similarly, since 737 die during the second year, the additional liability of the company at the end of the second year is $737,000. Now, if $694,693.18 is invested at 3½ per cent. for two years, it will accumulate to $737,000—the amount of the second year's death claims.

The following table shows how this method is applied up to the end of the mortality table. In the third column the present values of the losses (shown in the second column) are given. The fourth column contains the formula by means of which the third column is computed.

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TABLE II

I Age	II Losses	III Present Worth of Losses	IV Formula for Computing III
35	732,000	707,258.40	$\frac{732,000}{1.035}$
36	737,000	694,693.18	$\frac{737,000}{(1.035)^2}$
..	.....	.....	.....
44	812,000	575,626.80	$\frac{812,000}{(1.035)^{10}}$
..	.....	.....	.....
54	1,143,000	574,471.80	$\frac{1,143,000}{(1.035)^{20}}$
..	.....	.....	.....
95	3,000	367.93	$\frac{3,000}{(1.035)^{61}}$
Totals....	81,822,000	30,319,142.10	

The dots represent the other years, as given in the complete mortality table for the several ages from 35 on, the figures for which may be determined in the same manner.

With this amount on hand today, on the assumption that the same will earn 3½ per cent. interest, we shall have funds sufficient for the payment of every loss that can possibly occur in any year until the last 3 members die. This amount divided by 81,822, the number originally insured in our company, gives $370.55. In other words, if each member of our company will pay in cash the sum of $370.55, we shall have at date of organization a total of $30,319,142.10, or sufficient to pay every existing policy in full as the several deaths occur.

This $370.55 is termed the "net single premium," and is the *net* amount, without provision for expenses, which a man at age 35 should pay for a full-paid policy of $1,000.

§ 4. The Net Annual Premiums

The net single premium having been deposited, no further payments would ever be required; but most men would find it inconvenient to pay for their life insurance in a single sum. By means, however, of an equally simple mathematical process we may apportion that net single premium into an equivalent twenty payments to be made annually.

I shall not take your time this evening in going through the details

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of this calculation, but shall content myself with a statement of the principles involved and the result obtained. The net single premium of $370.55 is worth more than 20 premiums of $18.53 each, although $\frac{370.55}{20} = 18.53$. The reasons for this are easily seen. Suppose two men, A and B, each 35 years of age, take out policies for $1,000; A paying in 20 premiums and B in a single premium. Let us compare the accumulations on these policies after the expiration of twenty years. Suppose the company charges A (erroneously) the net sum of $18.53 per year. His first $18.53 would therefore be invested for 20 years, the last $18.53 for only 1 year. The second $18.53 would be invested 19 years, the next to last $18.53 for only 2 years. Thus on the average the company has the use of A's $370.55 for 10½ years. It has the use of B's net single premium of $370.55 for 20 years, however. Clearly, then, on account of the difference in interest accumulations, $18.53 per year for 20 years is not equivalent to $370.55 paid in a lump sum, in advance.

Moreover, some of those whose policies are on the 20-pay plan will die before the expiration of the 20 years, and a certain number of premiums will thus be lost to the company; and this loss, as well as the one mentioned above, must be counterbalanced by an extra charge to the survivors.

Calculations based on these two principles show that a single payment of $370.55 is equivalent to a promise, made by a man 35 years of age, to pay $27 per year for 20 years. Thus the *net* value of a 20-pay life policy at age 35 is $27 (in round numbers).

In the second column of Table III I give the net annual premiums, at five-year intervals, for the ages 25 to 40. In the third column are given the gross premiums,[1] for the same ages.

TABLE III

I Age	II Net Premium	III Gross Premium
25	21.50	30.25
30	23.60	33.20
35	27.00	36.87
40	29.30	41.46

[1] These gross premiums, differing slightly with the various companies, are necessarily only approximate.

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§ 5. The Loading—The Gross Premium

We see from the preceding that it costs the company $370.55, or $27 per year for 20 years, to insure a man, age 35, for the term of his natural life. Evidently, then, the actual office charge must be somewhat larger. The additional charge, or so-called "loading," must be sufficient to cover the various expenses—physician's fees, agent's commission, canvassing literature and supplies, and salaries of officers. It must also furnish a fund—a surplus—to provide for all other possible contingencies—such, for instance, as a mortality in excess of the tabular rate, interest earned less than the assumed rate of 3½ per cent., depreciation in the values of securities, loss of invested funds, etc. While the assumptions as to interest and mortality in the computation of the premium have been on the most conservative basis, nevertheless, so long as human judgment is fallible the possibility of error must be conceded. The fundamental principle of life insurance is safety, and, if mistakes are made at all, they must be on the side of safety. It is better to collect too much money than too little; hence the importance of making provision for unforeseen contingencies. Theoretically, when these contingencies are past, the overcharge is returned to the policy-holder in the form of dividends.

The net premium + loading = gross premium

or,

Loading = gross premium − net premium.

If the loading is divided by the net premium, the percentage of loading is obtained. In Table IV is given the percentage of loading of six-

TABLE IV

Company	Percentage of Loading (20-Pay Life, age 35)	Company	Percentage of Loading (20-Pay Life, age 35)
Aetna	34⅛	Mutual Life of New York	34⅛
Boston Mutual	33⅛	New England Life	31⅛
Connecticut Mutual	20	Northwestern	26⅝
Equitable	28½	New York Life	28½
Home Life	32 1/10	Pacific Mutual	33⅛
Maryland Life	33⅛	Provident	23½
Massachusetts Mutual	33⅛	Prudential	24
Mutual Benefit	21½	Union Central	29½

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teen well-known companies, on a 20-payment life policy, issued at age 35.[1]

§ 6. Dividends

At age 35 a 20-payment non-participating policy (on which no dividends are paid) costs, in round numbers, $31; that is to say, the company charges $4 per year for 20 years for expenses.

A participating policy at the same age (on which dividends are paid) costs about $37 per year; i. e., a loading of about $10. Deducting the $4 for expenses, you see there still remains $6, which goes into the surplus fund, to be returned, ultimately, as dividends. In some of the companies this fund has grown to between sixty and eighty millions of dollars. Nominally this money is all returned to the surviving policy-holders. The recent exposures in New York have shown how these funds have been employed for speculative and various questionable purposes.

Dividends are actually paid to the policy-holders. Deferred dividends should come from the following sources: savings in expenses (which experience shows are seldom made), interest earnings in excess of the estimated 3½ per cent., return of the original overcharge, and apportionment of the dividends of those who died.

§ 7. Surplus

The dividends deferred for twenty years have given rise to immense accumulations of wealth in several of the companies. Although the recent investigations have shown that it is unwise to allow the officers to manage such large sums without an accounting until the expiration of two decades, it must not be overlooked that the arguments which they employed in building up the present system are plausible ones.

First of all is the matter of safety. You doubtless remember the panic of 1893. At that time one of the companies, at least, was practically insolvent, but has since recovered, and, to provide against a similar contingency, has created a surplus of nearly $80,000,000. The recurrence of the same state of affairs today might wipe out part of the

[1] Some of these companies are on the 3 per cent. reserve basis, others on the 3½ per cent. basis. In all cases I have made due allowances for this in determining the percentages.

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surplus, and lose for the policy-holders most of their dividends; but the policies proper would be safe. Another argument frequently advanced is that many men are unable to save small sums of money, but, being obliged to pay their premiums, are thus in a measure compelled to save each year a certain amount, which in the course of twenty years accumulates to respectable proportions. While arguments could be advanced against this, it is, however, true that the point is, to a certain extent, well taken.

It is clear that, in order to insure the safety of the reserve—that is to say, of the policy proper—there ought to be a reasonable surplus. On the other hand it is equally clear that the officers of the company should not be permitted to manipulate the intrusted funds without being accountable to the policy-holders. Perhaps the solution of this difficulty lies in reducing the surplus, in some of the companies, to about one-fourth or one-fifth of the present dimensions, and the requirement of an annual statement to each policy-holder of his share in the year's profits.

But, aside from the fact that deferred dividends and the resulting large surplus funds lead to speculation, extravagance, and all manner of graft, there is another strong argument against this system. Even if by means of annual statements to the policy-holders and other methods of publicity the present evils were eliminated, the objection about to be given would still hold.

The principle of deferred dividends is in direct antithesis to the principle on which insurance is based. In insurance, the loser (i. e., the one who dies, or, in fire insurance, the one whose house is burned) is indemnified for his loss. The one who wins (i. e., who survives, or whose house does not burn) gets his money's worth in the *protection* he has enjoyed.

With deferred dividends the contrary is the case: the one who loses (i. e., dies) loses his dividends, and the one who wins (survives) gets the share belonging to his less fortunate neighbor. You see, this is exactly what happens in horse-racing: the one who guesses wrong pays, while the one who was correct in his surmise, wins. To summarize: Insurance is indemnity for loss, while deferred dividends is pure gambling.

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§ 8. The Regulation of Life Insurance Companies

The desirability of federal regulation of life-insurance companies is so generally recognized that it is unnecessary to advance arguments in its favor. But the decision of the Supreme Court that insurance is not commerce[1] seems to have taken the matter out of the reach of Congress. There are some optimistic insurance men who believe that the Supreme Court would, in view of developments since 1868, rule that *the interstate insurance business is interstate commerce*,[2] but for the present this decision constitutes a serious obstacle in the way of national legislation. Direct methods being thus impractical, the following indirect method has recently been proposed:

Congress, having jurisdiction in the District of Columbia and in the territories of the United States, could appoint a competent commission to investigate the conditions and methods of the various companies, and authorize or forbid them to do business in the District of Columbia and in the territories. Of course, such investigation would have to be voluntary on the part of the companies; any company, so desiring, would be at liberty to refuse to permit such an examination. Suppose, however, that the agents of three companies, A, B, and C, are trying to get your business. Company A has been investigated by the government and pronounced satisfactory; B has been investigated and pronounced unsatisfactory; while C has declined to allow the government to examine its affairs. Clearly, you would not trust B with your money, and you would be exceedingly suspicious of C, wondering why it is afraid to allow its books to be examined. You would undoubtedly select A as the safest company to insure with, and thus, A getting all the business, B and C would soon have to wind up their affairs.

Most of the insurance companies are organized on the mutual plan, wherein every policy-holder has a voice and vote in its government. In practice this suffrage is a farce. No one from afar ever goes to the annual meeting to cast his vote, and those living in the city where the meeting is held have not the time to attend it. When policies are taken out, the purchasers give their proxies to someone suggested by the

[1] This decision was handed down in December, 1868, in the case of Paul vs. Virginia.

[2] J. F. Dryden, Address on the regulation of insurance by Congress.

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agents, and this person has control of the company. This individual is, of course, a puppet in the hands of the officers of the company, at whose instructions the agents suggest his name. Thus, once in power, the officers of a mutual company have no difficulty in continuing so indefinitely.

The idea of a mutual organization, the members going each year from California to New York to vote at an election, is as absurd as the idea of all the citizens of the United States going annually to Washington to enact laws. In classic Greece the ideal government was a city of ten thousand, for then all citizens could come together and settle matters of state. This being out of the question in a great land like ours, a different principle is employed—the principle of representation.

Similarly, insurance companies should be representative instead of mutual, as conducted at present. The most convenient grouping for the purpose of electing representatives would probably be according to states. The policy-holders of each state could elect someone (a competent actuary) to represent them at the annual meetings of the various companies. Besides acting as a legislative body for the companies, these representatives could make annual reports to their constituents concerning the conditions of the companies. Of course, this scheme involves some expense, but each policy-holder's pro-rata share would be trifling. Fifty cents to one dollar per year would be sufficient, while the improvements and savings which these representatives could bring about (and consequent deduction in the cost of insurance, or increase in dividends) would be, relatively, very large.

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VOLUME IV NUMBER 2

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

FEBRUARY, 1907

Price, 50 Cents

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SIGNIFICANCE OF THE BANKING SITUATION IN COLORADO

By John B. Phillips

This paper concerns itself mainly with that part of the financial situation that is represented by the banking laws. Many causes have been operative in making the banking situation what it is in this state, and these causes are now operating to bring home to the minds of the people the need of certain changes in our banking legislation.

For many years Colorado was a frontier state. It was on the border between the developed and undeveloped resources of the United States. As a frontier state its population was engaged in exploiting undeveloped resources. For this purpose a different class of people is necessary from the kind of persons suited to carry on the industries in an older and more thickly settled region. In the frontier state the settlers must live distant from each other, hardships must be endured, self-reliance must abound.

These demands of the frontier had their effect on the immigrants that came here. Those men and women who left their homes in the East and came to develop the resources of our state were strong, healthy, aggressive and ambitious. The timid young men and women remained in the eastern states and engaged in the routine industries. The restless, adventurous, and daring young men and women came to seek their fortune in the new lands of the West. This is why so many of the captains of industry and leaders in politics are men trained in the enterprising spirit of the West.

In the history of the United States there is no more conspicuous fact than that the leaders from the very beginning have been men trained in the West. The frontier it seems has developed the dash and enterprise necessary to the leader. The West has always had an influence on the history of the country out of all proportion to its numbers. Washington, Jefferson, Jackson, Harrison, Taylor, and Lincoln were all men of the frontier. They represented the West. The War of 1812 was a war of

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the western people. It was pushed through against the opposition of the eastern section of the country. The western young men were in Congress and they made their influence felt. This they have not ceased to do notwithstanding the fewness of their numbers nor the scattered constituencies they represent.

One of the most significant effects of the frontier has been its encouragement of democracy. The doctrine of equal rights for all the population, man, woman, and child, finds its fullest expression in the legislation of the newer states of the West. This is the region where special privileges are likely to be the most unusual. The ideal of liberty is seldom lost sight of and a feeling of personal freedom quite unknown in the eastern lands of steady habits is the abiding prerogative of every citizen. Such a condition of affairs, such an intense democracy has tended to cultivate in our population a boundless spirit of self-reliance. The western states are the last ones to think any sort of paternal legislation necessary. They are the states that are most likely to be opposed to the state regulation of industry.

Aside from having been a frontier state, Colorado has been and is today very largely a mining state. The character of its population has been in some degree affected by this industry. Mining is a different industry from many of the more routine occupations. It is quite different from agriculture. A very different type of mind is needed to succeed in the mining industry from the type of mind needed for success in agriculture. There are ups and downs in the mining business. A large element of risk is always present. It calls for adventurous men. Timid men do not engage in the mining industry. Men of daring willing to play for large stakes are needed to develop a mining state.

Men with these traits of mind are restless and more or less unsettled. They are likely to be discontented when compelled to carry on routine industry yielding small returns. The prospect of sudden riches by strikes in mining makes the quiet life in routine industry dull and distasteful. A rich mining strike tends to start a speculative fever in the population. And in a population for many years engaged in this kind of industry there is a readiness to undertake speculative enterprises that is not found in the more lethargic states where only routine industry prevails.

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What is here said was more true of the population of Colorado in the early days than is the case now. Yet the effects of this early period have not been entirely obliterated from the population of today.

Such in a general way are the characteristics of our population. It is well that we have this kind of a population for just these qualities are still very largely needed to develop the magnificent possibilities of this state. We have hardly done more than make a beginning in the development of the resources here. A glance at the industrial map of the state shows that agriculture has been developed in but few sections. Its possibilities are vast. Improved processes in mining will greatly increase that industry. We need more railroads to open up some of the most fruitful sections of the state. And in manufactures why must we be dependent upon goods made in the eastern states? There seems to be no good reason why manufactures of all kinds should not develop in the state of Colorado. There is reason to hope that in the future even in spite of the discriminating railroad rates a great multitude of manufacturing concerns will make their homes on our soil.

Now what are some of the fundamental needs for the development of the possibilities of our state? We need an aggressive population. This we do not need to worry about. The kind of immigrants who come here will be men of enterprise. As a rule we are not likely to get a poor class of men to undertake the management of the industries. In industrial efficiency our population is now superior to that of many states, and there is reason to believe that the newcomers will not be inferior.

We need capital. This will come in the course of time. The higher rates of interest, the growth of sound credit, and the minimizing of the element of risk will bring in capital in abundance from other states. Among these the growth of sound credit and confidence is of very great importance.

Modern industry demands more credit and confidence than were needed in the earlier times. There has been a great increase in co-operation, specialization and division of labor. There is more interdependence in the modern world. Our water supply no longer comes from our own well; our meat is canned in a distant city. We are co-oper-

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ating and must place confidence in the honesty and good judgment of others.

The magnitude of modern industry has increased. There is greater competition in business. Modern business is done on credit, and, owing to the increase in competition and the size of industries, larger loans and more credit are constantly demanded. Therefore the result is an increase in the use of credit. Individuals who did not think of using credit a dozen years ago are now demanding it and having secured it are engaging in new enterprises.

The services of credit are of inestimable value in industry. Property cannot always be sold when the owner desires purchasing power. By the use of credit, however, property can be coined into money and exchanged for goods. The result is that the management of industry is put into the hands of the most capable managers by this use of credit. Individuals who happen to have the money on hand are not always the most capable to undertake the management of industry.

Credit is obtained through banks. They are the credit institutions of society. They flourish by having the confidence of the community. Their business is to coin goods into a means of payment. Their services in turning goods into credit and in this way encouraging the growth of industry and the progress of civilization are beyond measure.

The banker turns goods into purchasing power on his own responsibility. He alone decides how much credit shall be given in any case. He determines how large the mortgage on the house or farm shall be, and how large a loan on the various kinds of collateral offered may safely be given. The importance of good judgment in the banker is at once apparent. Poor judgment brings a banker to speedy financial ruin. The test of good banking is whether or not there is an actual movement of goods back of the credit given.

Banks give two kinds of credit, normal and abnormal. Normal credit is credit given for goods. It expands with growing wealth and the increase of commodities. When credit is given based on goods there is not likely to be an undue expansion of it. The expansion of this sort of credit is not to be feared and its effect on the general price level can not be more than temporary.

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On the other hand, abnormal credit is quite a different and much more serious matter. This kind of credit is an increase of purchasing power beyond the value of the goods owned. It may and usually does cause speculation and rising prices. When it is easy to get more credit than the collateral is worth, speculative enterprises will be undertaken. The industrial world is intoxicated. Hope abounds. Stock in the Keeley Motor Company can easily be sold. Conditions are established for growing tulips in Holland, and blowing bubbles in the South Sea. In short the foundations for commercial crises may be laid in this way.

There are two causes of abnormal credit. One is error of judgment by the banker, and the other is conscious fraud. It is possible for all human beings to err in their judgments of the values of commodities and securities. In a period of rising prices, it is exceedingly hard to tell whether the prices represent a healthy growth of industry or are the result of credit too freely given. The banker is liable to err at such times as are all the rest of us. It is said, however, that this is the unimportant cause of abnormal credit. The chief cause is believed to be conscious fraud. Excessive loans are made to promoters, and again, the directors are interested in some enterprise needing an excessive loan for its financiering. Their bank accordingly makes the loan. Sometimes they organize themselves into a separate company, and borrow largely from their bank. In this way, then, the greater amount of abnormal credit comes into existence. In any case the amount of credit to come into existence is very largely determined by the banker.

It is thus apparent that the power of the banker over industrial conditions is very great. He regulates the amount of credit and, as the industries of the country are conducted on a credit basis, he also to a large extent regulates the industries. Hence, the importance to the community of the good judgment and honesty of the banker. There is perhaps no class in the country whose judgment and honesty are so closely associated with our industrial progress. Upon no one class of men does the welfare of any community depend more than upon its bankers. It is therefore of the highest importance that society do what it can to place its bankers in an environment that will secure the wisest and most impartial of their judgments in the matter of extending credit to those

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about to undertake the management of industry. In so far as it can society should seek to minimize the temptations incident to the banking business.

There are two kinds of temptations in banking. Those incident to the fiduciary relationship, and those due to competition under modern conditions of life.

Banking is largely a fiduciary occupation. The banker possesses the confidence of the community and has on hand a large amount of money belonging to other persons and this he knows will not be called for during a considerable period of time. He also knows of many promising opportunities for investment of which the general public is entirely ignorant. He is familiar with the gigantic schemes of the promoter, and he is also acquainted with the tricks of corporation finance. In consequence, he is tempted more than other classes in the community to engage in speculation. Brokers in the larger cities say that it is not uncommon for bankers in the smaller places to furnish them money with instructions to go long or short on certain kinds of stocks.

Under modern conditions of industrial and social life competition is fiercer for the moneyed classes. The banker belongs to these classes. There is a certain cleavage in society between these and other classes. The financial interests are sharply defined. Standards are set by the leaders in financial and banking circles. The small banker tries to live up to the standard set by the great banker. This is conspicuously shown in the modern race to build elegant bank buildings. In the advertisements that are now running in the banking magazines it is quite the thing to have a picture of the building. Especially is this the case if the building is a fine one. Everyone is familiar with instances where one bank in a city has put up a fine building and the other banks have not been slow to build also and to try and surpass the buildings of their competitors. What is true of the buildings applies also to the interior furnishings. A series of articles is now running in the *Bankers' Magazine* showing the interiors of the more important banks in the larger cities of the United States. Nearly all the illustrations are of interiors finished in marble. Formerly bank fixtures were in some sort of wood, but with the increase of wealth in the country it seems that only marble will answer

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the purpose. These articles show if they show anything that there is a most fierce competition in the matter of bank fixtures and furnishings. It is true the public is frequently foolish enough to allow its patronage of a financial institution to be in some considerable measure determined by the elegance of the interior of the banking-house. It would seem, however, that with the revelations the past two years have made in the management of great financial institutions, the public will in the future be more attracted by the character of the banker than by the elegance of marble fixtures and sumptuous furniture. If this is true such extravagant banking houses will be less necessary in the banking business of the future.

Competition has developed another practice among the banks that is generally regarded as unfavorable to sound banking. This is the practice of paying interest on deposit balances. Superintendent Kilburn of New York says that the banks in his state are paying too high rates of interest on these balances. The banks do this in order to get money, and are thus tempted to loan on poorer security as it will pay a higher rate of interest. He thinks this is a matter that the banks and trust companies should settle among themselves. The banks in Albany made an agreement in 1905 not to pay interest on balances under $10,000. The agreement was a success. Very little money it is said was withdrawn from the city in consequence.[1]

These general considerations on the effect of competition in the banking business apply with much force to Colorado. Our bankers are exposed to the same temptations that confront those in other states. They must regulate the amount of credit to be given and they must also prevent the growth of abnormal credit. This is not easy. It has been shown that our population is composed of aggressive and adventurous pioneers and their descendants as well as a large element of enterprising immigrants from other states. Come to seek their fortune in the West, they bring little capital and they want credit. Our own citizens are optimistic; they have faith in speculative enterprises. The fever of speculation brought on by the development of mining in this state has not yet entirely run off. Fortune-seeking immigrant and optimistic

[1] "Report of Supt. of Banks, N. Y.," *Bankers' Magazine*, Vol. LXXII, p. 110, 1906.

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prospector and promoter make their appeal to our bankers. Whether or not too much credit shall be given them depends upon the banker's judgment. This is why we need banking laws that will assist the banker in deciding wisely, and thus protect ourselves from an undue expansion of credit and its consequent injury to sound business enterprise.

Among the more important defects in the banking laws of Colorado are confusion and the absence of supervision. There is confusion in the law which defines the banking powers of trust companies.[1] The law enumerates the powers of trust companies and seems to include all the banking powers and then says that these companies shall not engage in banking except as herein authorized. This last clause is of doubtful meaning and just what was the intent of the legislature in enacting it has never been made clear. It looks as though it might have been inserted to make the bill pass easily so that the unwary might not suspect that trust companies had banking powers. It recalls the character of the Manhattan Company of New York City. Some of the anti-federalists, among them Aaron Burr, wanted a charter for a bank in New York. The legislature was then in session but it was a federalist legislature and Burr well knew that it would not grant him a charter. He therefore conceived a method of obtaining one by stealth. There had been an epidemic of yellow fever in New York and it was commonly thought to be due to the poor water supply. Burr went to the legislature and asked for a charter for a company to provide a pure water supply for the city of New York. In the bill which he drew and presented to the legislature was a clause that any surplus of the capital of the company might be employed in any moneyed transactions not inconsistent with the constitution and laws of the state. The federalists, even such astute men as John Jay, did not mistrust that banking powers were concealed in this innocent looking clause. This company immediately started a bank with half of its capital and exists as the Manhattan Company to this day. It long since ceased to be a water company.

The liability of stockholders in banks and trust companies is not clearly defined. The law of 1885 says that shareholders in banks, savings banks, trust, deposit, and security associations shall be individu-

[1] *Laws of 1891*, pp. 102–105, § 3; *Mills' Statutes*, § 544c.

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ally responsible in double the amount of the par value of the stock owned by them.[1] The law of 1891 says the stockholders in trust companies shall be liable to the amount of their stock and in addition thereto. What the phrase "in addition thereto" means has not been settled. It may mean that the liability of the stockholders is unlimited. If such be its meaning it is bad as it will tend to check the growth of credit institutions.

Again, in the matter of limiting the loans to any one person, firm, or corporation, the law should be changed. Banks may not loan more than 25% of their capital in this way.[2] Savings banks and trust companies are not hampered by law in the amount of such loans.

The most serious defect in the banking laws of Colorado is the absence of supervision. As has been already pointed out, the people of the West are self-reliant. They do not look with favor on government control. There is a feeling that each citizen can look out for himself. It is difficult, however, for each individual to look out for himself in so important a matter as banking. The state has taken over the coinage of money because it can secure a good money system with less difficulty than any individual, no matter how self-reliant he may be. So of the banking system. The state can by a careful supervision of the banks save energy for the individual. To attain their greatest usefulness banks and trust companies must secure the maximum confidence of the public. The danger of bank failures must be reduced to a minimum. Frequent examinations are an aid to good bank management. Thirty-five states and territories require examinations of their banks and trust companies; some annually, some twice a year.[3] There seems to be a growing tendency to require two examinations a year. State examinations of credit institutions has become a settled principle of American financial policy.

A state superintendent of banks is an important officer and the manner of his appointment is not easy to decide. Above all things this office should be kept out of politics. The national bank examiners are

[1] *Laws of 1885*, p. 264, § 1; *Mills' Statutes*, § 533.

[2] *Laws of 1885*, p. 51, § 1; *Mills' Statutes*, § 223.

[3] Arizona; California; Connecticut; Delaware; District of Columbia; Florida; Georgia; Illinois; Indiana; Iowa; Kansas; Louisiana; Maine; Maryland; Massachusetts; Michigan; Minnesota; Missouri; Montana; Nebraska; New Hampshire; New Mexico; New York; North Carolina; North Dakota; Oklahoma; Pennsylvania; South Carolina; South Dakota; Texas; Utah; Vermont; West Virginia; Wisconsin; Wyoming.

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appointed largely through pull.[1] Each examiner makes 150 perfunctory examinations a year. Hence, the contempt for them which is so prevalent among the bankers. Probably the best way to secure a bank examiner or superintendent of banks whose position will not in any way be dependent upon political pull will be to have him appointed by the governor on the recommendation of the state bankers' association. In this way a capable man will be secured and his efficiency will not be injured by the machinations of the professional politician.

When a superintendent of banks has been appointed he should have sufficient power to make his influence effective. He should be empowered to examine banks at any time and on his own initiative. His examination should be thorough enough to make him familiar with the class of loans and their security. Unless he becomes reasonably familiar with the loans of the institution, his examination is of little value. The state superintendent of banks should also have the power to close a bank and apply for a receiver when it is conducted in an unsafe, dangerous, or unlawful manner. In some states this officer has the aforesaid power, though it is not general. The federal officers can close a bank only when it is insolvent. When the state examiner can close a bank if it is conducted unlawfully, a force is set in motion that makes for good banking. Knowing the state officer had this power, the banks would be careful in the management of their business.

Trust Companies

Whatever system of regulating banks may be instituted by the state, it should be applied equally to the regulation and examination of trust companies. These institutions have grown up among the banks for the purpose of meeting the demand for certain financial operations which it was impossible for the banks to perform. In most states the powers given to them are somewhat vague and generally the charters have been construed to give to these corporations banking powers. As a result these companies are generally engaged in the banking business. In many states these institutions are more favored by the law than are banks. This is the case in Colorado as has been pointed out. No

[1] *Bankers' Magazine*, New York, Vol. LXXII, p. 57, 1906.

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reserve is required to be maintained by trust companies, nor is there any limit to the amount they may loan to one person. The result of this is the encouragement of an unhealthy competition to get deposits. The companies pay too high rates of interest on balances and the banks are compelled to meet this competition in order to retain their patrons. It is said that trust companies sometimes borrow on collateral and reckon the sums so received with their deposits in order to make a more favorable showing, and in this way attract more trust funds. The concerns not subject to inspection are more likely to resort to schemes of this nature.

In the state of New York supervision of trust companies was instituted in the year 1874. The first year of its operation three trust companies which had been conducted in a dangerous and illegal manner were compelled to suspend operations. $6,000,000 of deposits were paid out in full to their owners.[1] Had no state examinations been made and only reports of the officers of these institutions been depended upon, the three companies might have gone on till a much worse condition prevailed and the depositors might have lost a large part if not all of their money. Before state examinations were begun in New York trust companies had seldom failed whose recently published statements did not show a surplus.[2]

There is a pronounced movement in the United States toward bringing trust companies engaged in the banking business under the same law that applies to banks. The bank examiner as a rule examines trust companies as well as banks and the time is not far distant when the two institutions will be regulated by the same law as far as the business of banking is concerned.

As an indication of the latest tendencies in bank and trust company legislation these acts passed by the last legislature of the state of New York are important:

1. Overdrafts are prohibited to officers, directors, and employees of banks and trust companies.

2. Commission is denied to an officer or director of a bank for procuring loans from that bank to any corporation.

[1] *Bankers' Magazine*, New York, Vol. LXI, p. 787, 1900.

[2] CATOR, "Trust Companies in the United States," *Johns Hopkins University Studies in Historical and Political Science*, Series 20, Nos. 5–6, May–June, 1902, p. 53.

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3. Banks and trust companies must report on call at least every three months. Formerly they reported twice a year on specified dates.

4. State superintendent of banks must examine banks and trust companies twice a year instead of annually as heretofore.

5. Directors or three of them must make two examinations of the institution, one in April and the other in October of each year. Report of the examination must be filed with the state banking department. In this examination the directors are to ascertain especially the character of the loans and the security therefor.

6. Not over 10 per cent. of the capital and surplus may be loaned to any one person, firm or corporation, if unsecured, and not over 40 per cent. if secured.[1]

The greatest cause of bank failures is excessive loans to an individual, firm, or corporation in which the officers of the bank or trust company are interested. The provision of law limiting the amount that may be loaned to a single firm is most difficult to enforce. President Hamilton of the American Bankers' Association says the old law limiting the amount of loans by national banks to an individual, firm or corporation was constantly violated.[2] This law provided that 10 per cent. of the unimpaired capital might be so loaned. Under the new law passed at the last session of Congress the limit is 10 per cent. of the unimpaired capital and surplus. The only way of enforcing this act is by suit to forfeit the bank's charter. This remedy has always proved too violent; the examiners and the controller have not had the courage to enforce it, and it has remained a dead letter.

After all, it should be remembered that thoroughly effective bank supervision is well nigh impossible. No matter how acute the examiner, he may be deceived. No outside examination of a bank can supply honesty and good judgment for the officers. We should enact such legislation as will keep the business of banking upon a high plane and make it a calling that will attract only men of honor and integrity. In this way the banker can render his greatest service to society and in an increasing degree set in motion one of the strongest forces making for industrial progress.

[1] "Report of Supt. of Banks, New York," *Bankers' Magazine*, Vol. LXXII, pp. 105–106, 1906.
[2] *Bankers' Magazine*, New York, Vol. LXXII, p. 95, 1906.

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THE TERRITORY OF COLORADO[1]

By Frederic L. Paxson

It is commonly taken for granted that the Kansas-Nebraska legislation of 1854 settled the territorial question in the United States, and that the territorial question itself was only a single phase of the larger question of slavery. The tyranny of the slavery problem over the historical mind has completely subordinated the problem of the expansion of the agricultural West, the settlement of new areas, and the providing of adequate institutions of government for the citizens of the frontier. The erection of the territory of Colorado in 1861 is itself proof that slavery was not in its own day destructive of interest in all other topics, however it may have impeded their consideration, and is an illuminative precedent in showing the manner in which territorial problems have been forced upon Congress and ultimately adjusted.

The acquisition of the southwest at the treaty of Guadalupe-Hidalgo in 1848 extended the legal frontier of the United States far beyond the frontier of actual settlement and compelled Congress to give serious thought to the subdivision of large and relatively uninhabited areas of public lands. The act of May 30, 1854, which has commonly been misunderstood as saying the last important word upon the territorial question, merely marked the end of the earliest period of preliminary adjustment. The residuum of the Louisiana purchase and the lands acquired through the Mexican War were at last distributed among two states, California and Texas, and four territories. The two territorial organizations of New Mexico and Utah covered the whole area between California and the Rocky Mountains, while the fortieth parallel divided most of the unorganized area east of the mountains into Kansas and Nebraska territories.

The distribution in effect at the end of the session of 1854 was only preliminary, and within three years Congress had begun to consider the division of three of these territories, Nebraska, Utah, and New Mexico,

[1] Reprinted from *The American Historical Review*, Vol. XII, No. 1, Oct., 1906, pp. 53–65.

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whose gigantic size precluded the rigorous execution of law by single territorial establishments. In the first session of the Thirty-fifth Congress, 1857–1858, it was finally proposed to divide two of these territories, creating Arizona in the western end of New Mexico and Nevada in the western end of Utah,[1] while the next session brought a bill to erect Dakota in the northern end of Nebraska.[2] The division was required by various facts of population and migration. The location of the great Pacific trails, the discovery of silver-mines, the willingness to restrict the territory of the Mormons, all appear as inspiring a further subdivision of the scantily populated West.

The Congress of 1857–1858 passed no laws for the erection of new territories in the areas marked out in the debates. There is some internal evidence throughout these and later debates that the young sponsors of the new Republican party were interested in territorial development as a means of continuing the antislavery argument which all parties had agreed in 1854 to forget. But whatever may have been the motives underlying the agitation, the arguments make entirely clear the facts that the boundaries of 1854 were only temporary and that the great, shapeless territories must some day be divided. The session of 1857–1858 contented itself with the suggestion of two new territories of Nevada and Arizona; when the same Congress met for its second session in 1858–1859, two more new territorial projects, those of Dakota and Jefferson, had been added to its list.

In the migrations to the far West, beginning to be heavy in the forties, the two principal routes had branched from the Missouri River near its northern bend on the western boundary of the state of Missouri. From this point the northern or Oregon route had run westwardly along the Platte, the southern or Santa Fé route along the Arkansas. And at the one hundred and second meridian the two trails were already two hundred and fifty miles apart, and were deviating still further to the northwest and southwest respectively.[3] The angle between the trails covered the

[1] *Congressional Globe*, 35 Cong., 1 Sess., pp. 62, 2090.

[2] *Congressional Globe*, December 21, 1858, p. 159.

[3] An act of Congress of May 19, 1846, provided for the erection of forts along the Oregon route. Fort Kearney was established on the Platte 310 miles west of Fort Leavenworth, and Fort Laramie 337 miles beyond Fort Kearney, in 1848. *Ex. Doc. 5*, 31 Cong., 1 Sess., Serial 569, pp. 94, 225. Fort Kearney became the most important post in the northern route and was not abandoned until 1871. *House Ex.*

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heart of the "great American desert," which Major Long had described in 1820 as utterly uninhabitable for man, and which men had since 1820 been willing to take at the word of the explorer. It was this uninviting, uninhabited area which in the fall of 1858 appeared before Congress. It demanded not a slicing-up of existing great territories, but a new grouping of lands taken out of the crest of the Rockies and in part from every one of the territories of the central and south West. To this area those who advocated the new project gave the name of the Territory of Jefferson.

Since the discovery of gold in California and the rush of the forty-niners along the overland trails there had always been bodies of prospectors scattered over the mountain region. Rumors of gold discoveries in the desert triangle had been heard early in the fifties, while the panic of 1857 sent fresh bands of men to try their luck in the great game. In the year 1858 numerous parties were exploring the lands between the Arkansas and the Platte, and the arrival at Omaha on January 5, 1859,[1] of several quills filled with gold-dust proved to the Missouri settlers that success had rewarded the prolonged search, and started a new westward movement of large proportions to the Pike's Peak country.

The city of Denver, named for the governor of Kansas territory, became the settlement around which the Pike's Peak country grouped itself in the winter of 1858–1859. Boulder and Golden, Colorado City and Pueblo became secondary centers, each situated as Denver was, at a point from which trade and travel branched from the great trails and entered the valleys leading to the mining-camps.[2]

As early as June, 1858, the forks of the South Platte and Cherry Creek were being examined by prospectors. As the summer and fall advanced more adventurers appeared; the names of Montana, Highland, Auraria, and St. Charles came to designate settlements in the vicinity of the forks; and by November the inclusive name of Denver was heard.[3]

Doc. 12, 43 Cong., 2 Sess., Serial 1164. Lieutenant-Colonel William Gilpin was on July 20, 1847, detailed to a station near the crossing of the Arkansas to keep the peace along the Sante Fé trail. *Ex. Doc. 1*, 30 Cong., 1 Sess., pp. 136, 139.

[1] *Transactions and Reports of the Nebraska State Historical Society*, II. 315. One of the men mentioned as bringing the gold, Albert B. Steinberger, was elected a delegate to Congress by the Auraria meeting of November 6, 1858. He deserted his mission and never reached Washington. His later romantic career in a Pacific kingdom is described in *House Ex. Doc. 161*, 44 Cong., 1 Sess., Serial 1691, 125 pp.

[2] An old military trail connecting Fort Union and Fort Laramie ran through some and within easy distance of all these towns. JEROME C. SMILEY, *History of Denver* (Denver, 1901), 229.

[3] The best detailed account of these earliest settlements is found *ibid.*, 200 *et seq.*

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In a governmental way the new camp of Denver was situated in Arapahoe County, Kansas. But Arapahoe County had never been organized, and remained only a name until after the legislature of Kansas abolished it in February, 1859.[1] The settlers themselves saw from the start that the five hundred miles of trail between the diggings and the territorial capital forbade protection from, as well as interference by, that government, and that their political salvation lay nearer home. They saw that four territorial governments were involved in the Pike's Peak country, and that the country was in itself an economic unit. It was this understanding which pressed upon Congress early in 1859 with a new territorial scheme, and which even earlier than this had produced a spontaneous political activity in the mountain camps.

The beginnings of Colorado politics are to be found in the movement originating in Denver in November, 1858, and culminating in the territorial organization of Jefferson in November, 1859. The origin seems to have been in a typical early snowfall that drove the miners into their bins in November, 1858, and by enforcing idleness upon them gave an opportunity for talking politics.[2] Perhaps two hundred miners were in Denver when the snowfall came, of whom some thirty-five attended a meeting on November 6, and determined to erect a new government for the Pike's Peak country. "Just to think," wrote one of them, "that within two weeks of the arrival of a few dozen Americans in a wilderness, they set to work to elect a Delegate to the United States Congress, and ask to be set apart as a new territory! But we are of a fast race and in a fast age and must prod along."[3] To secure an attention to their demand they chose one Hiram J. Graham to appear in their behalf at Washington, and one A. J. Smith to represent them in the legislature of Kansas.[4] The arrival of these men in Omaha seems at once to have confirmed

[1] HELEN G. GILL, "The Establishment of Counties in Kansas," *Kansas Historical Collections*, VIII. 452.

[2] OVANDO J. HOLLISTER, *Mines of Colorado* (Springfield, Mass., 1867), 17, is responsible for the statement that ten inches of snow fell on October 31, 1858.

[3] *Ibid.*, 18.

[4] *Ibid.*, 90; SMILEY, 305, 530; FRANK FOSSETT, *Colorado: a Historical, Descriptive, and Statistical Work on the Rocky Mountain Gold and Silver Mining Region* (Denver, 1876), 17; FRANK HALL, *History of the State of Colorado* (Chicago, 1889–1895, 4 vols.), I. 208; H. H. BANCROFT, *History of the Pacific States*, Vol. XX., *Nevada, Colorado, and Wyoming* (San Francisco, 1890), 402.

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the report of the discovery of placer gold in the western streams and to have announced the birth of a new center of population. Four months after the first election a new political whim struck Denver camp, and a set of local officers was chosen March 28, 1859, for Arapahoe County, Kansas, in spite of the fact that Kansas had on February 7, 1859, foreseen the coming emigration, reshaped Arapahoe, and cut out of it five new counties of Montana, Oro, El Paso, Fremont, and Broderick.[1] The only significance of this March election, for its officers seem never to have held power, lies in the fact that nearly eight hundred votes were then cast. Already the heavy migration of 1859 had begun to throw its thousands along the trails to Denver. Whether these thousands were sixty or one hundred, no one can tell today; but it is certain that after half or more of them had gone home in disgust there remained in Jefferson nearly thirty thousand settlers to reiterate the demand that Congress provide a government for them and to maintain their provisional territory for the interim.

The mission of Hiram J. Graham to the second session of the Thirty-fifth Congress failed to produce either an enabling or a territorial act. His arrival in Washington in January, 1859, was followed by the appearance of his territorial scheme in the House, when A. J. Stephens introduced a bill for the erection of Jefferson Territory.[2] Grow of Pennsylvania moved to amend the name to Osage, and when it was reported back from the Committee on Territories on February 16, it was tabled without any serious discussion or opposition.[3] The fate that had postponed the erection of new territories in 1858 continued to postpone in 1859 when Jefferson had been added to the list. Slavery debate forbade territorial legislation, and the single scheme which had a real population behind it was left without local or legal government, and was forced to find its way through 1859 until the next session of Congress might perhaps attend to business and provide for it a legal frame.

[1] SMILEY, 246, 531; HALL, I. 183; BANCROFT, 402; BASKIN AND CO., *History of the City of Denver, Arapahoe County, and Colorado* (Chicago, 1880), 187.

[2] His petition was presented in the Senate on January 27. *Cong. Globe*, 35 Cong., 2 Sess., p. 621. Stephens reported bills in the House for Dakota, Arizona, and Jefferson territories on January 28, 1859. *Ibid.*, 657.

[3] *Ibid.*, 1065.

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The migration of 1859 multiplied the population of Denver many times and increased the need for orderly government as well by the character as by the number of its inhabitants. A knowledge that no aid from Congress could be had for at least a year revived the local movement until it induced a group of pioneers to hold a caucus, with William Larimer in the chair, on April 11, to consider the local situation.[1] As a result of this caucus a call issued for a convention of representatives of the neighboring mining-camps to meet in the same place four days later. And on April 15, 1859, the camps of Fountain City, El Dorado and El Paso, Arapahoe, Auraria, and Denver met through their delegates, "being fully impressed with the belief, from early and recent precedents, of the power and benefits and duty of self-government," and feeling an imperative necessity "for an immediate and adequate government, for the large population now here and soon to be among us . . . . and also believing that a territorial government is not such as our large and peculiarly situated population demands."[2]

The deliberations thus informally started ended in a formal call for a constitutional convention to meet in Denver on the first Monday in June for the purpose, as an address to the people stated, of framing a constitution for a new "State of Jefferson." "Shall it be," the address demanded, "the government of the knife and the revolver, or shall we unite in forming here in our golden country, among the ravines and gulches of the Rocky Mountains, and the fertile valleys of the Arkansas and the Platte, a new and independent State?"[3] With a generosity characteristic of the frontier the convention determined the boundaries of the prospective state as the one hundred and second and one hundred and tenth meridians of longitude, and the thirty-seventh and forty-third parallels of latitude—an area including, in addition to the present state of Colorado, large portions of Utah and Nebraska and nearly half of Wyoming. The arrival in Denver, a week after this convention, of

[1] HALL, I. 184; SMILEY, 306; BANCROFT, 403.

[2] The first issue of the *Rocky Mountain News*, April 23, 1859, contains an account of these meetings and texts of the resolutions and addresses. The newspaper at once becomes an invaluable source. SMILEY, 306–309.

[3] The address was drawn by a committee of five, and was printed in the *Rocky Mountain News*, May 7, 1859. SMILEY, 309.

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William N. Byers was important in that it brought an active advocate of statehood into the field, and produced on April 23 the first number of the *Rocky Mountain News*.[1]

When the statehood convention, called on April 15, met in Denver on June 6, the time was inopportune for concluding the movement, for large numbers of the pioneers who had rushed out over the plains for "Pike's Peak or Bust" were already on their disconsolate way back, "busted." The first reputation of the diggings was based upon light and exaggerated discoveries of placer gold; when productive lodes came into view they called for more capital and experience than most of the early prospectors possessed.[2] The height of the gold boom was over by June, and the return migration made it somewhat doubtful whether any permanent population would be left in the country to need a state. So the convention met on June 6, appointed some eight drafting committees, and adjourned, to await developments, until August 1.[3] But by the first of August a line had been drawn between the confident and the discouraged elements in the population, and for six days the convention worked upon the question of statehood. As to permanency, there was by this time no doubt; but the body divided into two nearly equal groups, one advocating immediate statehood, the other shrinking from the heavy taxation incident to a state establishment and so preferring a territorial government with a federal treasury to meet the bills. The body, too badly split to reach a conclusion itself, compromised by preparing the way for either development and leaving the choice to public vote. A state constitution was drawn up on one hand,[4] while, on the other, was prepared a memorial to Congress praying for a terri-

[1] The State Historical and Natural History Society of Colorado has in its collection a file of the *Rocky Mountain News* which is substantially complete, and which has been used in the preparation of this paper. Byers reached Denver April 21 with his printing outfit. He had prepared for prompt issue by printing in Omaha two pages of his first four-page sheet. But even thus the honor of the first issue in Colorado is contested by John L. Merrick's *Cherry Creek Pioneer*. Both papers appeared first on April 23, 1859, Merrick's first being also his last, for Byers at once bought him out and gained control of the field for himself. SMILEY, 247, 248; HALL, I. 184; BANCROFT, 527, has a useful note upon Colorado journalism.

[2] Horace Greeley visited Denver, arriving June 6, 1859. HORACE GREELEY, *An Overland Journey, from New York to San Francisco, in the Summer of 1859* (New York, 1860), 137.

[3] SMILEY, 277; HALL, I. 208; BANCROFT, 404, gives a list of officers; *Rocky Mountain News*, June 11, 1859.

[4] BYERS, in an editorial, *ibid.*, July 23, had supported the statehood argument by reference to the admission clause in the Louisiana treaty of 1803.

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torial government;[1] and both documents were submitted to a vote on September 5, 1859, when the memorial was chosen instead of the constitution.[2] Upon October 3 another election was held, pursuant to the memorial, and a delegate to Congress was chosen in the person of Beverly D. Williams, who was local agent of a new Leavenworth and Pike's Peak Express Company which had run its first coach into Denver in May,[3] and whose zeal for mail contracts may have inspired some of his earnestness for congressional countenance.

The adoption of the territorial memorial failed to meet the need for immediate government or to prevent the advocates of such government from working out a provisional arrangement pending the action of Congress. These advocates held a mass-meeting in Denver on September 24,[4] while on the day that Williams was elected to Congress, October 3, they also elected delegates for a preliminary territorial constitutional convention, and upon October 10 this convention met. "Here we go," commented Byers, "a regular triple-headed government machine; south of 40 deg., we hang on to the skirts of Kansas; north of 40 deg., to those of Nebraska; straddling the line, we have just elected a Delegate to the United States Congress from the 'Territory of Jefferson,' and ere long, we will have in full blast a provisional government of Rocky Mountain growth and manufacture."[5] In this convention of October 10, 1859, the name of Jefferson was retained for the new territory, the boundaries of April 15 were retained, and a government similar to the highest type of territorial establishment was provided for.[6] If the convention had met pursuant to an enabling act, its career could not have been more dignified. It adopted a constitution with little trouble, and then dissolved after calling an election for territorial officers for October 24, 1859. The election of this day seems to have been orderly and generally participated

[1] The *Rocky Mountain News* printed on August 6 the journal of the convention; on August 13 the constitution; and on August 20 the memorial.

[2] SMILEY, 311; *Rocky Mountain News*, September 17, reports the vote.

[3] SMILEY, 251; ALICE POLK HILL, *Tales of the Colorado Pioneers* (Denver, 1884), 41; ALEXANDER MAJORS, *Seventy Years on the Frontier* (Chicago and New York, 1893), 165, 228; Majors was a member of the great freighting firm of Russell, Majors, and Waddell, which was ultimately wrecked when the "Pony Express," which had been started in April, 1860, collapsed.

[4] *Rocky Mountain News*, September 29; SMILEY, 312.

[5] *Rocky Mountain News*, October 6.

[6] HOLLISTER, 92; SMILEY, 314; BANCROFT, 406; text in *Rocky Mountain News*, October 20.

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in, for the need of government was obvious. It resulted in the choice of a legislature and an executive staff headed by Governor Robert W. Steele of Ohio.[1] Two weeks later Steele met his assembly and delivered his first inaugural address.

The territory of Jefferson, which thus came into existence on November 7, 1859, is one of the most illuminating incidents in the history of the American frontier. From the days of the State of Franklin[2] the frontiersman has always resented his isolation, and upon receiving evidence of governmental neglect has always been ready to erect his own government and care for himself in a political way. There are many incidents in the history of statehood movements in which settlement has rushed forward more rapidly than legal institutions, with results in the erection of illegitimate provisional governments. But none of these illegitimate governments has been erected more deliberately or conducted with more propriety than this territory of Jefferson. The fundamental principle of American government which Byers expresses is applicable at all times in similar situations:

> We claim [he wrote in his *Rocky Mountain News*] that any body, or community of American citizens, which from any cause or under any circumstance, is cut off from, or from isolation is so situated, as not to be under any active and protecting branch of the central government, have a right, if on American soil, to frame a government, and enact such laws and regulations as may be necessary for their own safety. protection, and happiness, always with the condition precedent, that they shall, at the earliest moment when the central government shall extend an *effective* organization, and laws over them, give it their unqualified support and obedience.[3]

And the life of the spontaneous commonwealth thus called into existence is a creditable witness to the American instinct for orderly government.[4]

When Congress met in December, 1859, the provisional territory of Jefferson was in operation, while its delegates were in Washington pressing the need for governmental action. One of the agents, B. D. Williams,

[1] BINCKLEY AND HARTWELL, *Southern Colorado* (Canon City, 1879), 5; SMILEY, 315.

[2] GEORGE HENRY ALDEN, "The State of Franklin," in *American Historical Review*, VIII. 271–89; see also the Clarksville (Indiana) Resolves, *ibid.*, II. 691–93.

[3] *Rocky Mountain News*, January 4, 1860.

[4] F. L. PAXSON, "The Territory of Jefferson; a Spontaneous Commonwealth," in *University of Colorado Studies*, III. 15–18.

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was elected on October 3, 1859;[1] the other, George M. Willing,[2] claimed to be the regular choice at this election, and, though apparently not recognized at Washington, reiterated the arguments of Williams and the territorial memorials. Both houses of Congress gave some heed to the facts thus presented. They received from President Buchanan on February 20, 1860, a message transmitting the petition from the Pike's Peak country,[3] and bills to meet the demand were at least introduced into each house. The Senate upon April 3 received a report from the Committee on Territories introducing Senate Bill No. 366, for the erection of Colorado territory;[4] while Grow of Pennsylvania reported to the House on May 10 a bill to erect in the same region a territory of Idaho.[5] The name of Jefferson disappeared from the project in the spring of 1860, its place being taken by sundry other names for the same mountain area. Several weeks in the spring were given in part to debates over this Colorado-Idaho scheme as well as to the older Dakota, Nevada, and Arizona territories. As in the past sessions of Congress, the debate was less upon the need for the erection of several territorial governments than upon the attitude which any bills should take upon the slavery issue. In the demands of the Republican leaders in the territorial debates from 1858 to 1867 can be measured the advance of antislavery attitude, from exclusion of slaves through guarantees to free negroes, and up to the abolition of the "white" clause in the franchise qualification. This obsession of Congress by the slavery debate precluded territorial legislation in the years 1859 and 1860, but the session ended with the reasonableness of one of the demands well presented. In a secondary way the governmental argument was strengthened by petitions for the service of the mails, for post-roads from Fort Laramie to Golden City and from

[1] A memorial of January 4, 1860, describes this election. *House Misc. Doc. 10*, 36 Cong., 1 Sess., Serial 1063, p. 7. The text of his certificate of election is in *Rocky Mountain News*, August 29, 1860.

[2] Two letters written by Willing to Lewis Cass, Secretary of State, are in the Department of State, Bureau of Rolls and Library, in a volume of territorial papers marked, Minn., Neb., Ore., Wyom., Col. D. C., Kan., Mich., Miscellaneous, and are brought to the writer's attention through the courtesy of W. G. Leland, Esq., of the Carnegie Institution, Department of Historical Research.

[3] RICHARDSON, *Messages and Papers of the Presidents*, V. 580; *Sen. Ex. Doc. 15*, 36 Cong., 1 Sess., Serial 1027; *Cong. Globe*, 36 Cong., 1 Sess., p. 841, February 20, 1860; p. 871, February 23.

[4] *Ibid.*, 1502.

[5] *Ibid.*, 2047, 2066, 2077. The memorials of Williams had been presented in the House by Green Adams of Kentucky, on February 15. See under that date *ibid.*, 789; *House Journal*, Serial 1041, 283.

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Atchison to Denver. And though on May 12 all of the territorial bills were tabled for the session,[1] the need for them was clearer than it had been at any time since the passage of the Kansas-Nebraska Bill in 1854.

The territory of Jefferson, as organized in November, 1859, had been from the first recognized as merely a temporary expedient. The movement for it had gained weight in the summer of that year from the probability that it need not be maintained for many months. When Congress, however, failed in the ensuing session of 1859–1860 to grant the relief for which the pioneers prayed, the wisdom of continuing for another year the life of a government admitted to be illegal came into question. The first session of its legislature had lasted from November 7, 1859,[2] to January 25, 1860. It had passed comprehensive laws[3] for the regulation of titles in lands, water, and mines, and had adopted civil and criminal codes. Its courts had been established and had operated with some show of authority. But the services and obedience to the government had been voluntary, no funds being on hand for the payment of salaries and expenses. One of the pioneers from Vermont wrote home, "There is no hopes [*sic*] of perfect quiet in our governmental matters until we are securely under the wing of our National Eagle." In his proclamation calling the second election Governor Steele announced that "all persons who expect to be elected to any of the above offices should bear in mind that there will be no salaries or per diem allowed from this territory, but that the General Government will be memorialized to aid us in our adversity."[5] Upon this question of revenue it was that the territory of Jefferson was wrecked. Taxes could not be collected, since citizens had only to plead grave doubts as to the legality to evade payment. "We have tried a Provisional Government, and how has it worked?" asked William Larimer in announcing his candidacy for the office of territorial

[1] *Cong. Globe*, 36 Cong., 1 Sess., 2079–2085.

[2] The *Rocky Mountain News* had the text of Steele's message in its issue of November 10, 1859. It is also found in *House Misc. Doc. 10*, 36 Cong., 1 Sess., Serial 1063, pp. 11–15.

[3] *Provisional Laws and Joint Resolutions Passed at the First and Called Sessions of the General Assembly of Jefferson Territory, Held at Denver City, J. T., November and December, 1859, and January, 1860. Published by Authority* (Omaha, N. T., Robinson and Clark, 1860, pp. 298). The writer knows of the existence of only two copies of this pamphlet.

[4] *Early Day Letters from America (now Denver) Written by Libeus Barney to the Bennington Banner, Bennington, Vermont, 1859–1860* (Denver?, n. d., pp. 88), 54.

[5] Proclamation of September 18, in *Rocky Mountain News*, September 19, 1860.

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delegate. "It did well enough until an attempt was made to tax the people to support it."[1] More than this, the real need for the government became less apparent as 1860 advanced, for the scattered communities learned how to obtain a reasonable peace without it. American mining-camps are peculiarly free from the need for superimposed government. The new camp at once organizes itself on a democratic basis, and in mass-meeting registers claims, hears and decides suits, and administers summary justice. Since the Pike's Peak country was only a group of mining-camps, there proved to be little immediate need for central government, for in the local mining-district organizations all of the immediate needs of the communities could be satisfied. So loyalty to the territory of Jefferson, in the districts outside Denver, waned during 1860, and by the summer of that year its moral influence had virtually disappeared. Its administration held together, however. Governor Steele made efforts to rehabilitate its authority, holding an election on October 22, 1860, to choose a second legislature.[2] On November 12 he met his second assembly, he himself having been re-elected by a trifling vote, to continue the tradition of the territory. From November 12 to November 27 it sat at Denver; then until December 7 it continued its sessions at Golden. And upon this last day it dissolved itself forever.[3]

When the Thirty-sixth Congress met for its second session in December 1860, the Jefferson organization was in the second year of its life, yet in Congress there was no more immediate prospect of territorial action than there had been since 1857. Indeed, the election of Lincoln brought out the eloquence of the slavery question with a renewed vigor that monopolized the time and strength of Congress until the end of January. And had not the departure of the southern members to their states cleared the way for action, it is highly improbable that even this session would have produced results of importance.

Grow had announced in the House on December 12, 1860, a general territorial platform similar to that which had been under debate for three

[1] Letter of August 21, *ibid.*, August 22, 1860.

[2] BANCROFT, 410; SMILEY, 321; HALL, I. 249.

[3] HOLLISTER, 123.

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years.[1] Until the close of January the southern valedictories held the floor, but at last the admission of Kansas on January 29, 1861, revealed the fact that pro-slavery opposition had departed and that the long-deferred territorial scheme could have a fair chance.[2] On the very day after Kansas was admitted, with its western boundary at the twenty-fifth meridian from Washington, the Senate revived its Bill No. 366 of the last session and took up its deliberation upon a territory for Pike's Peak.[3] Only by chance did the name Colorado remain attached to the bill. Idaho was at one time substituted for Colorado, but was amended out in favor of the original name on February 4 as the bill passed the Senate.[4] The boundaries were materially cut down from those which the territory had provided for itself. Two degrees were at once taken from the north of the territory, and after some hesitation over the Green River the western boundary was placed at the thirty-second meridian from Washington. In this shape, between the thirty-seventh and forty-first parallels, and the twenty-fifth and thirty-second meridians, the bill passed the Senate on February 4, the House on February 18, and received the signature of President Buchanan on February 28.[6] The absence of serious debate in the passage of this Colorado act is excellent evidence of the merit of the scheme and the reasons for its being so long deferred.

On February 28, 1861, the territory of Colorado became a legal fact; Buchanan left it to his successor to erect the territorial establishment. President Lincoln, after some delay caused by pressure of business at Washington, commissioned General William Gilpin as first governor of the territory. Gilpin had long known the mountain frontier; he had commanded a detachment on the Santa Fé trail in the forties, and had written prophetic books upon the future of the country to which he was now sent. His loyalty was unquestioned, and his readiness to assume responsibility went so far as perhaps to cease to be a virtue. He arrived in Denver at his new post on May 29, 1861,[7] and within a few days was

[1] *Cong. Globe*, 36 Cong., 2 Sess., p. 81.
[2] LEVERETT W. SPRING, *Kansas* (Boston, 1885), 266.
[3] *Cong. Globe*, 36 Cong., 2 Sess., p. 639.
[4] *Ibid.*, 729.
[5] F. L. PAXSON, "The Boundaries of Colorado," in *University of Colorado Studies*, II. 87–94.
[6] *Cong. Globe*, 36 Cong., 2 Sess., pp. 729, 777, 1003, 1206, 1274.
[7] HALL, I. 266; FOSSETT, 106.

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ready to take charge of the territory and to receive from the hands of Governor Steele[1] such authority as remained in the provisional territory of Jefferson.

[1] Steele issued a proclamation recommending the citizens to remain "loyal and true" to the federal government on May 23, *Rocky Mountain News*, May 29, 1861. He handed over the government to Gilpin on June 6. SMILEY, 321, 322.

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THE MOLLUSCA OF COLORADO.[1] PART I

By Junius Henderson

When the writer began the study of the molluscan fauna of Colorado a few years ago, the fact that most emphatically and persistently presented itself was the almost total lack of interest in and knowledge of the subject among the biologists of the state. A few conchologists had visited our mountain regions, but the great plains area was untouched except for the visit of Mr. Simpson to the extreme northeastern corner of the state. In response to requests for information, directed to the teachers of various branches of natural history in our public schools and other institutions of learning, it was not at all encouraging constantly to receive the reply that there are no mollusks (or "shell-fish," in popular parlance) in Colorado. However, a few teachers and laymen were found who were sufficiently interested to have collected shells in a modest way and some faithful friends promised to help the work along —promises which have been fulfilled—for such work, to be effective, must be co-operative. If this paper does nothing more than convince teachers and the general public that we have in all parts of the state an interesting and much neglected fauna, it will be worth while.

In addition to this lack of interest, another great difficulty and one which may never be wholly overcome, has arisen from doubts as to the accuracy of identification in many instances in the early reports, some of which doubts cannot now be cleared up. The matter was further complicated by the confusion of species new to science with species theretofore described. The fact that the records are scattered through publications not available in small libraries and that the literature of the subject is in other respects unsatisfactory, tended to discourage local naturalists from undertaking the work which we now feel should be no longer delayed.

A number of lists of Colorado mollusks were long ago published as a result of the efforts of a few collectors, as shown by the bibliography accompanying this sketch, but none of them were at all complete. Inger-

[1] This paper will be followed by one treating the Gastropods.

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soll, with the Hayden Survey, Yarrow with the Wheeler Survey and Cockerell working independently were among the early collectors, the latter still continuing his interest, in connection with other branches of natural history.

In view of the abundance of Mollusca in almost every pond, lake, stream, and water-hole of the plains, to find so few published records from the eastern half of the state and that some of our most abundant and two of our largest shells are wholly unrecorded was somewhat surprising. It is worthy of especial note that in the plains area almost our only records of fresh-water species, except the few from Lodge Pole Creek and Ft. Morgan, are confined to the area west of a line drawn from Pueblo to Crow Creek, while about the only land snails reported from east of that line are the *Succinea* collected at Mono, on the eastern boundary of the state. The reason is that local naturalists are not generally interested in conchology and visiting conchologists are usually in haste to reach the mountains.

There is perhaps no part of the state in which a careful search would not reveal both land and fresh-water shells containing the living animals. This paper does not deal with fossil forms except incidentally. The land snails are with a few exceptions quite small, the principal exception being the genus *Oreohelix*. This may account for the fact that they are not well known to teachers of zoology or to the general public. The fresh-water snails average much larger, the *Limnæas* of some species reaching a length of an inch and a half, while several bivalve species reach a length of over three inches. Both land and fresh-water shells are found from the valleys nearly to the top of the range. Almost every pond, lake, or stream will yield some of the latter, while the former may be expected anywhere in damp places under rocks, boards, dead leaves, etc. Generally speaking, they are not apt to be found under resinous trees or among pine needles, but they may sometimes be found even among the pines, in places where there are also quaking aspens and other desiduous trees.[1]

Colorado, because of its great variation in altitude, temperature, humidity, and other conditions, and because of the mountains and other

[1] Compare V. Sterki, "Shells in Pine Forests," *The Nautilus*, Vol. V 1891-92, p. 118.

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supposed barriers, is considered an important field for extensive and intensive collecting and study of mollusks. Up to the present time the study of the influence of altitude upon mollusks in this region has given chiefly negative results. Instead of dwarfing the species as in Montana and other regions where the cold of high altitudes is more intense,[1] the higher altitudes seem more favorable to land snails than lower levels, because of increased humidity. The finest specimens of *Oreohelix strigosa* and *Vitrina alaskana* found have been at 11,000 and 9,300 feet respectively. Ingersoll[2] reports the same fact concerning *Thysanophora* (*Microphysa*). On the other hand, the larger fresh-water snails we have found do not occur in the lakes at timber line at all. Among bivalves we have found *Pisidia* at 11,000 feet, *Calyculina* at 8,500 feet, but no *Unionidæ* at all in the mountains or anywhere in the western half of the state. The only thick-shelled *Unionidæ* found in the state are those from Lodge Pole Creek and Las Animas County, though a thin-shelled species (*Strophitus edentulus pavonius*) is found close to the foothills.

The majority of our species, both land and fresh water, are also found in the Mississippi Valley and eastward, probably having reached Colorado from the eastward or northward, but, on the other hand, there is an impressive and probably significant absence of such genera as *Polygyra*, *Campeloma*, *Viviparus*, *Goniobasis* and *Pleurocera*, which are so well represented in the eastern states. The distribution of *Oreohelix* and *Thysanophora* indicates that they have crossed the mountains from the westward; but if so, the former must have arrived at the base of the foothills long ago, as suggested by fossil specimens in the Quaternary deposits. *Viviparus*, *Campeloma* and *Goniobasis* lived in northeastern Colorado, together with *Anodonta*, *Unio*, and *Physa*, during the latter part of Cretaceous time, as shown by the Laramie fossils of Crow Creek and neighboring localities, but the three first-named genera have disappeared from the state, while *Physa* is among our most abundant mollusks at the present time. *Anodonta* is reported from Lodge Pole Creek, its near relative *Strophitus* is our most common large bivalve, and *Unio* has been found in two localities. *Lymnæa*, *Planorbis*, and *Unio* occur in Jurassic strata

[1] Morton J. Elrod, *Bull. Univ. Mont.*, No. 17, p. 259.

[2] *Eighth Ann. Rept. Hayden Survey*, p. 398.

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near Canyon City, but, owing to the absence of fresh-water beds from most of the Cretaceous formations, they are not found between the Jurassic and Laramie. The Jurassic *Unios* are not of distinctively North American type. *Omphalina?*, *Lymnæa*, *Planorbis* and *Sphærium* are found in the Tertiary lake beds of Florissant.[4] The three last-named genera are still represented in the state by living species.

This attempt to incorporate into one paper the published records of our Mollusca, together with new records based upon recent collections, must necessarily be more or less incomplete and in some respects inaccurate, because of the present unsatisfactory *status* of some nominal western species, the impossibility of now certainly determining the accuracy of identification of early collections and the inaccessibility of some important publications which might furnish further records or other information. However, it is hoped that this bringing-together in brief form of the numerous records must at least greatly aid in future investigations, and afford a fresh starting-point from which our molluscan fauna may be attacked with renewed vigor, besides presenting the additional records for the first time given to the public. It is quite possible that some published records have been overlooked.

The writer is very grateful to Dr. Henry A. Pilsbry and Mr. E. G. Vanatta, of the Academy of Natural Sciences of Philadelphia; Dr. Paul Bartsch, of the U. S. National Museum; Mr. Frank C. Baker, of the Chicago Academy of Sciences; Dr. V. Sterki, of New Philadelphia, Ohio; Professor T. D. A. Cockerell, of the University of Colorado; Mr. Chas. T. Simpson, of Lemon City, Florida; and Mr. Bryant Walker, of Detroit, Michigan, for their kindly assistance in the identification of difficult material, for reading and revising portions of the manuscript, for additional records they have furnished and for many suggestions for the improvement of the paper in various ways; also to those whose names are mentioned in the catalogue for the collections they have so kindly brought in from various parts of the state. The records from Mr. Vanatta's manuscript are based upon specimens in the collection of the Academy of Natural Sciences of Philadelphia. Further collections,

[4] Cockerell, "The Fossil Mollusca of Florissant, Colorado," *Bull. Amer. Mus. Nat. Hist.*, Vol. XXII, Art. XXVII, pp. 459–462, 1906.

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data, suggestions, or corrections are invited from any who are interested in the subject, in order that errors may be corrected or omissions supplied in a supplemental paper if deemed advisable.

In the catalogue the figures in bold-faced type indicate the numbers of the several publications in the bibliography, the light-faced figures indicating the pages. The illustrations, except Plates I and II, are electrotyped from originals used in publications of the Smithsonian Institution, by courtesy of the authorities of that institution.

The following species and subspecies are herein recorded for the first time from this state, so far as we have ascertained: *Strophitus edentulus pavonius, Unio tetralasmus camptodon, Calyculina securis, Pisidium noveboracense, P. compressum, Oreohelix strigosa albofasciata, O. haydeni, Pupilla sonorana, Bifidaria armifera, Vertigo ventricosa elatior, Vallonia gracilicosta, Helicodiscus eigenmanni arizonensis, Succinea salleana, S. haydeni, Lymnæa bulimoides techella, L. caperata, Planorbis exacuous, Ancylus caurinus, Physa integer, P. anatina, P. lordi, P. hawnii?.*

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LIST OF LOCALITIES

[In order to avoid designating the portion of the state in which the various stations are located in each instance, this table is presented]

Animas Valley, La Plata Co.
Ault, Weld Co.
Baker's Park, Mineral Co.
Bear Canyon, Boulder Co.
Black Lake, Summit Co.
Black Lake Creek, Summit Co.
Blue River, Summit Co.
Boulder, Boulder Co.
Buzzard Creek, Mesa Co.
Canyon City, Fremont Co.
Carrizo Creek, Las Animas Co.
Cattle Creek, Garfield Co.
Chalk Creek, Chaffee Co.
Clear Water Creek, Mesa Co.
Clear Creek, Mineral Co.
Cottonwood Gulch, Saguache Co.
Cotapaxi, Fremont Co.
Craig, Routt Co.
Crow Creek, Weld Co.
Cunningham Gulch, San Juan Co.
Davidson's Ranch, Boulder Co.
Del Norte, Rio Grand Co.

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Dillon, Summit Co.
Divide Creek, Garfield Co.
Eagle River, Eagle Co.
Egeria, Routt Co.
Eldora, Boulder Co.
Empire, Clear Creek Co.
Estes Park, Larimer Co.
Fairplay, Park Co.
Florence, Fremont Co.
Florissant, Teller Co.
Ft. Collins, Larimer Co.
Gault, Weld Co.
Gleneyre, Laramie Co.
Glenwood Springs, Garfield Co.
Granby, Larimer Co., N. of Grand Lake.
Grand Mesa, Mesa Co.
Greeley, Weld Co.
Hardscrabble Canyon, Custer Co.
Horseshoe Bend Gulch, Custer Co.
Hot Sulphur Springs, Grand Co.
Howardsville, San Juan Co.
Hygiene, Boulder Co.
Kremmling, Grand Co.
Lake George, W. of Florissant.
Lake of the Clouds, Custer Co.
Little Blue Creek Gunnison Co.
Lodge Pole Creek, Logan Co.
Los Pinos River, La Plata Co.
Lyons, Boulder Co.
Micawber Mine, Custer Co.
Magnolia, Boulder Co.
Mam Mts., Mesa Co.
Meeker, Rio Blanco Co.
Mineral Creek, Mineral Co.
Monon, Baca Co.
Muddy Creek, Grand Co.
Naomi, Summit Co.
Northrop, Chaffee Co.
North Mam Creek, Garfield Co.
Owen's Lake, Boulder Co.
Plateau Creek, Mesa Co.
Pottery Pass, Summit Co.
Powderhorn, Gunnison Co.
Red Cliff, Eagle Co.
Rio La Plata, La Plata Co.
Roaring Fork, Garfield Co.
Rock Creek, Routt Co.
Round Mt., Custer Co.
Saguache Creek, Saguache Co.
Salida, Chaffee Co.
St. Mary's Lake, Mineral Co.
St. Vrain Canyon, Boulder Co.
Short Creek, Custer Co.
Slate Creek, Summit Co.
Squaw Creek, Eagle Co.
Straight Creek, Summit Co.
Surface Creek, Delta Co.
Swift Creek, Custer Co.
Twin Lakes, Lake Co.
Twin Mesa, Gunnison Co.
Two Elk Creek, Eagle Co.
Wales Canyon, Pueblo Co.
Ward, Boulder Co.
Wellsville, Custer Co.
West Cliff, Custer Co.
West Ten Mile Creek, Summit Co.
Wet Mt. Valley, Custer Co.
Wheeler, Summit Co.
White Earth Creek, Gunnison Co.
Williams Canyon, El Paso Co.
Willow Creek, Custer Co.
Windsor, Weld Co.
Zion Peak, Lake Co.

Systematic Table of Colorado Molluscan Genera

CLASS PELECYPODA (*Bivalves*)

Order Prionodesmacea
Superfamily Naiadacea
Family Unionidæ
Genera *Anodonta*, 1 sp.
Strophitus, 1 sp.
Anodontoides, 1 sp.
Lampsilis, 3 sp.
Unio, 1 sp.

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Order Teleodesmacea
Superfamily Cyrenacea
Family Sphæriidæ
Genera *Sphærium*, 4 sp.
Calyculina, 3 sp.
Pisidium, 5 sp.

CLASS GASTROPODA (*Univalves*)

Subclass ANISOPLEURA

Superorder Euthyneura
Order Pulmonata
Suborder Stylommatophora
Family Helicidæ
Genera *Oreohelix*, 3 sp. and var.
Thysanophora, 1 sp.
Polygyra, 1 sp.
Family Pupillidæ
Genera *Pupoides*, 2 sp.
Pupilla, 3 sp.
Bifidaria, 2 sp.
Vertigo, 7 sp. & va.
Family Achatinidæ
Genus *Cochlicopa*, 1 sp.
Family Valloniidæ
Genus *Vallonia*, 3 sp.
Family Zonitidæ
Genera *Vitrina*, 1 sp.
Vitrea, 1 sp.
Euconulus, 1 sp.
Zonitoides, 3 sp.
Family Limacidæ
Genus *Agriolimax*, 2 sp.
Family Endodontidæ
Genera *Pyramidula*, 2 sp.
Helicodiscus, 2 sp.
Punctum, 1 sp.
Sphyradium, 1 sp.
Family Succineidæ
Genus *Succinea*, 8 sp.
Suborder Basommatophora
Family Limnæidæ
Genera *Limnæa*, 12 sp. and var.
Planorbis, 5 sp.
Family Ancylidæ
Genus *Ancylus*, 3 sp.
Family Physidæ
Genera *Physa*, 11 sp.
Aplexa, 1 sp.

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Superorder Streptoneura
Order Ctenobranchiata
Suborder Streptodonta
Family Valvatidæ
Genus *Valvata*, 1 sp.

Key to Colorado Mollusca

Inherent difficulties in the description of shells make it almost impossible to formulate a key which is sufficient of itself for the identification of species, but this key may be of assistance to students, who, however, must in the end, depend upon more extended descriptions, in other works. The great majority of our species are described in Baker's *Mollusca of the Chicago Area*, published by the Chicago Academy of Sciences; Binney's "A Manual of American Land Shells," *Bulletin No. 28* of the *United States National Museum*, Binney, Bland and Tryon's "Land and Fresh-Water Shells of North America," Parts I, II, III, and IV, *Smithsonian Miscellaneous Collections*, Nos. 143, 144, 194, and 253, respectively; Prime's "Monograph of American Corbiculidæ." *Smithsonian Miscellaneous Collections*, No. 145.

PELECYPODA (Bivalves)

A. Shell more than 2 inches in length, lateral teeth posterior to cardinal teeth.
  a. Rather thin shelled, cardinal teeth slightly or not at all developed.
    1. Coarse wrinkles on beaks in parallel double loop.
Anodonta grandis giganteus
    2. Coarse parallel wrinkles on beaks, not doubly looped.
Strophitus edentulus pavonius
    3. In addition to coarse wrinkles, fine ridges on umbones, directed posteriorly.
Anodontoides ferussacianus
  b. Shell solid, cardinal teeth well developed.
    1. Length about twice the height or more.
      aa. Beak wrinkles 5 to 7, in long poorly defined double loop, cardinal teeth double in both valves. **Lampsilis anodontoides**
      bb. Umbones with about 14 fine undulating ridges. **Lampsilis luteola**
      cc. Umbones with 5 to 8 coarse concentric ridges. **Unio tetralasmus camptodon**
    2. Length about ½ greater than height, 6 coarse beak wrinkles not doubly looped, cardinal teeth double only in left valve. **Lampsilis ventricosa**

B. Shell less than one inch in length, lateral teeth both anterior and posterior.
  a. Animal with one short siphon; mussel generally small to minute, 1.5 to 8 mm. long, in a few species 8 to 12 mm.; anterior part generally longer than posterior.
Pisidium spp.
  b. Animal with 2 longer siphons, connate at their bases for a longer or shorter distance; mussel averaging larger, 5 to 20 mm. long; anterior part generally shorter than posterior.
    1. Shell and hinge generally stouter, beaks rarely calyculate (capped).
Sphærium spp.

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2. Shell and hinge very slight, beaks in most species calyculate (with caps).
Calyculina spp.

(After consultation with our best authorities on these three genera it seems best to omit any attempt to put the species in a key, in the present state of knowledge).

GASTROPODA (Univalves)

* Terrestrial Snails, with Well-developed Shell

A. Height of shell less than width.
a. Width of adults more than 8 mm.
1. Lip well reflexed. **Polygyra monodon**
2. Lip not reflexed, whorls 5, marked by one or more dark spiral bands.
aa. Depressed, sometimes reaching width of 25 mm. and height of 10 mm.
Oreohelix strigosa
bb. Smaller with same number of whorls, width 16 mm., height 8 mm., otherwise as *strigosa*. **Oreohelix strigosa concentrata**
cc. Spire elevated, last whorl descending toward aperture.
Oreohelix strigosa cooperi
dd. Similar to *strigosa* but with several riblike revolving lines crossing the lines of growth. **Oreohelix haydeni**
b. Width less than 8 mm.
1. Discoidal, apex level with or below top of last whorl.
aa. Whorls not equally visible above and below, growth lines not crossed by parallel spiral lines, whorls 5 or 6, width 4 mm., height 2.5 mm.
Thysanophora ingersolli
bb. Whorls equally visible above and below, growth lines crossed by fine, equidistant, parallel spiral lines, width 3.5 mm., height 1.5 mm.
Helicodiscus parallelus
cc. Larger, width 4.5 to 5 mm. **H. eigenmanni arizonensis**
2. Apex raised more or less above top of last whorl, peristome not everted or reflected.
aa. Rather depressed.
1. Thin, brownish horn, smooth, shining, whorls 4, last enlarging very rapidly, width 3.5 to 4 mm. **Vitrea hammonis**
2. Very fragile, greenish white, transparent, smooth, glassy, whorls 3, last composing most of shell, width 5 mm. **Vitrina alaskana**
3. Smooth, growth lines fine, requiring a lens, color amber to whitish, whorls 4 or 5, width 5 mm., heighth 3.75 mm., usually smaller.
Zonitoides arboreus
4. Minute, spire nearly flat, growth lines strong under lens, color white, width 2.5 mm., height 0.75 mm. **Zonitoides minusculus**
5. As *minusculus*, except striæ more riblike, interspaces microscopically striate, spire less depressed. **Zonitoides conspectus**

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6. Umbilicus wide, exhibiting all volutions from below, striæ riblike, width 5 to 5.75 mm., height 2.5 to 2.75 mm.
Pyramidula cronkhitei anthonyi

7. Shaped as *anthonyi*, but smoother, irregularly wrinkled or ribbed.
Pyramidula cockerelli

8. Minute, reddish or brownish, marked by strong striæ and fine spiral lines, strongest on base, width 1 mm., height, 0.5 mm.
Punctum pygmæum

bb. Elevated, smooth, shining, amber-colored, whorls 6, increasing regularly, umbilicus not perforated or scarcely so, width 2.25 to 3 mm., height 1.75 to 2.75, juveniles easily mistaken for young *Pupa*.
Euconulus trochiformis

3. Minute, umbilicate, depressed, apex raised above top of last whorl, persistome everted or reflected, light unicolored, width 2 to 2.6 mm., height 1 to 1.3 mm.

aa. Rather solid, shining, not ribbed, growth striæ fine, persistome reflected and white. **Vallonia pulchella**

bb. Solid, striæ stronger and more distinct than in *pulchella* and rather irregular, last whorl expanding and descending toward aperture, peristome reflected and porcelain-white. **Vallonia gracilicosta**

cc. Thin, ribs fine and numerous and bearing membranes which give the ribs of fresh specimens a roughly sharp appearance, last whorl expanding and descending toward aperture, persistome everted but not reflected into a decided lip. **Vallonia cyclophorella**

B. Height of shell greater than width.

a. Aperture very large, peristome simple, shell thin and fragile, imperforate, whorls usually 3, increasing rapidly.

1. Long and narrow.

aa. Aperture long and narrow, exhibiting all volutions within to apex, last whorl more than twice size of others combined, pellucid, color light or greenish horn, growth lines minute, height 15 to 20 mm., width 6.5 to 9 mm.
Succinea retusa

bb. Aperture but little more than half length of shell, more nearly circular than in *retusa*, color straw or greenish horn, sometimes with a reddish tinge, shining, whorls 3, height 6 to 12 mm., spire sharp, growth lines minute (our specimens all small, about 5 mm). **Succinea avara**

cc. Pale horn or whitish, spire short and acute, coarsely striate, shining, height 20 mm., width 8 mm., aperture 13 mm., long and widest below middle.
Succinea sillimani

dd. Pale greenish horn-color, striæ coarse and irregular, surface without luster, aperture widest about middle and $\frac{2}{3}$ the length of shell, height of shell 12 mm., width 6 mm., fold of columella distinct. **Succinea rusticana**

ee. Color dull horn, growth lines rude, aperture about $\frac{2}{3}$ length of shell, last

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whorl constituting nearly whole shell, columella gently curved and without fold, height 13 mm. **Succinea nuttalliana**

ff. Thin, shining, amber-colored, spire short, acute, whorls convex, last marked by growth wrinkles, light callus on columella, aperture ½ length of shell, expanding below and exhibiting volutions to apex, height 15 to 21 mm., width 7 to 9 mm. **Succinea haydeni**

gg. Whitish horn-colored, pellucid, shining, delicately striate, marked irregularly with impressed spiral lines, aperture oval, angular above, height 18 to 20 mm. **Succinea salleana**

2. Wider in proportion to height.

aa. Whorls full and rounded, growth wrinkles irregular, interspaces often crossed by parallel spiral lines. **Succinea grosvenori**

bb. Similar to *avara* but more compact, shorter in proportion to width. **Succinea stretchiana**

b. Aperture ⅓ length of shell, shell oval, highly polished, whorls 6, gradually increasing in size, growth lines very fine, peristome simple, length 5.5 to 6 mm., width 2.25 mm., an unmistakable species. **Cochlicopa lubrica**

c. Aperture very small, shell small, spire long in proportion to aperture, generally cylindrical with obtusely rounded apex, whorls numerous, not usually increasing much after the first 2 or 3.

1. Whorls 6 or 7, except *B. pentodon.*

aa. Brownish horn color, shell tapering regularly from body whorl to apex, growth lines fine, base produced, aperture toothless, umbilicus deep and open, persistome reflected, height 5 mm., width 2 mm. **Pupoides marginatus**

bb. Horn color, small, cyclindrical, irregularly ribbed, aperture toothless, peristome narrowly reflected and white, umbilicate, umbilicus bounded by an angle, height 3.5 mm., width 1.6 mm. **Pupoides hordaceus**

cc. Dark chestnut or bay, lower 4 whorls about equal diameter, growth lines fine, aperture usually toothless, umbilicus perforate, persistome somewhat reflected, height 4 mm., width 1.5 mm. **Pupilla muscorum**

dd. Light brown, last whorl ascending and rapidly expanding toward aperture, external callus separated from subreflected peristome by deep constriction, teeth obtuse, 1 parietal, 1 columellar, 1 far within base of aperture, height 3 mm., width 1.5 mm. **Pupilla blandi**

ee. Brownish horn color, cylindrical, whorls gradually increasing, striated rugulose, coarser near aperture, lip abruptly but narrowly everted, teeth white, parietal deep seated, long and spiral, columellar perpendicular along columella, palatal (the inferior) strong often with threadlike prolongation inward, height 2.6 mm., width 1.3 mm. **Pupilla sonorana**

ff. Light horn color, inflated, vitreous. shining, smooth, growth lines crowded, first 3 whorls increasing rapidly, last 3 about equal, 1 single or double parietal lamella, a massive tooth on columellar wall far within, 1 at lower

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right-hand angle of aperture, 1 above it, sometimes 1 or 2 others, peristome broadly reflected, height 4 to 4.5 mm., width 2.25 mm.
Bifidaria armifera

gg. Whitish, very small, outline as in *armifera*, whorls 5, 8 teeth, 1 on columella, 3 on base, 3 on inner side of lip, a long one extending downward from parietal wall, peristome slightly reflected, height 2 mm., width about 1 mm.
Bifidaria pentodon

hh. Chestnut brown, perforate, middle 3 whorls about equal, last expanding toward base, with tendency to separate from penultimate one, peristome simple, slightly reflected over umbilicus. **Sphyradium edentulum**

2. Whorls 5 or less.

aa. Color dark amber, ovate, whorls 5, increasing somewhat regularly and rapidly, last inflated, peristome somewhat expanded, with groove behind and thickened within, umbilicus expanded, 2 parietal teeth, 1 columellar, 2 basal, 1 inside outer margin of aperture, height 3 mm., width 1.5 mm.
Vertigo ovata

bb. Amber-colored, narrowly ovate, highly polished, whorls 5, one tooth on middle of lower lip, and one on parietal wall, one on columella and a small one within outer lip. **Vertigo tridentata**

cc. Color light chestnut, cylindrical ovate, whorls 4 or 4½, increasing slightly after the second, last about ½ length of shell, umbilicus slightly open, teeth variable, 1 to 3 parietal, 1 columellar, 1 at lower left-hand angle, 2 on oblique base and outer lip, sometimes 1 above and 1 below latter two, peristome thickened but not reflected, width 1 mm. **Vertigo gouldi**

dd. Ovate to oblong ovate, whorls 4, smooth, polished, one parietal tooth, 2 columellar and 2 basal, outer margin of aperture fleunose, peristome reflected. **Vertigo ventricosa elatior**

ee. Shape as in *gouldi*, but last 2 of the 3½ whorls equal, umbilicus distinct, lip reflected, 1 parietal tooth, 1 columellar, 2 well within lip.
Vertigo modesta corpulenta

ff. Much like *corpulenta*, but usually an additional lamella in variable stages of development in the lower left-hand angle of aperture.
Vertigo modesta parietalis

gg. Minute, brown, shining, striate, peristome thick and brown, teeth brown, 1 long parietal tooth, 1 columellar, 2 long lamellæ on outer lip, lower one the larger, height 1.5 mm. **Vertigo coloradensis**

hh. Chestnut brown, shining, whorls 5, upper 3 tapering to blunt apex, last ascending toward aperture as in *Pupilla blandi*, 1 short entering parietal tooth, a smaller one to right and nearer upper angle, a strong entering columellar lamella, 2 long folds within outer lip, lower one the larger, height 2 mm., width 1.1 mm. **Vertigo concinnula**

ii. Very small, color dark chestnut, growth lines minute, angle of convergence toward produced base and blunt apex about equal, whorls 5, 2 projecting

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parietal teeth, 1 columellar, 1 basal, a long curved one within outer lip, a long entering lamella curving from outer basal angle to behind columella, peristome white, unreflected, umbilicus open, deep, height 1.4 mm., width 0.9 mm. **Vertigo milium**

**** Terrestrial Naked Slugs**

A. Unicolored, unspotted. **Agriolimax campestris** and var.

B. Darker reticulated lines on lighter ground color giving a spotted appearance. **Agriolimax agrestis**

***** Fresh-Water Snails**

A. Discoidal, whorls coiled in one plane.

a. More than 5 mm. in width.

1. Color white to brown, whorls 4, spire flat from above, depressed and showing 2½ to 3 whorls from below, whorls slightly carinate above, width 15 to 20 mm. **Planorbis trivolvis**

2. Distorted form of *trivolvis*, plane of inner whorls inclined to that of outer whorl so that carina of 3d whorl forms a shoulder on right side and sinks beneath outer whorl on left side. **Planorbis plexata**

3. Whorls 3, sharply carinate above and below, conically depressed above and below, smaller than *trivolvis*, V-shaped aperture extending above top of body whorl. **Planorbis bicarinatus**

b. Less than 5 mm. in width.

1. Color bright horn to black, umbilicus wide and shallow, showing all volutions from above and below, apex depressed somewhat below top of last whorl. **Planorbis parvus**

2. Whitish, with deeper, narrower umbilicus than *parvus*, apex not sunken. **Planorbis umbilicatellus**

3. Dark brown, periphery of outer whorl sharply carinate. **Planorbis exacuous**

B. Small, depressed conical, patelliform.

a. Fragile, sides parallel or incurved in middle, apex elevated and curved backward, ⅔ from anterior end of shell, extreme length 4 mm., width 1.1 mm., height 1 mm., usually much smaller. **Ancylus fragilis**

b. Similar to, if not identical with, *fragilis*. **Ancylus caurinus**

c. Pale, thin, delicate, sides nearly straight, not quite parallel, apex sharp, ⅔ from anterior end, turned to right. **Ancylus parallelus**

C. Spire depressed, but apex raised considerably above body whorl, color brownish, shining, whorls 3½, last much deflected, making aperture nearly round and continuous, peristome simple and nearly continuous, easily distinguished from all other Colorado species. **Valvata lewisi**

D. Spire elevated, sinistral.

a. Rather wide in proportion to height, last whorl usually constituting larger part of shell. **Physa** spp.

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(Owing to unsatisfactory status of species of this genus it is deemed best not to attempt to differentiate them in this key.)

b. Distinguished from *Physa* by long, narrow form, very highly polished shell and simple mantle margin of animal, spire long, body whorl subcylindrical, height of shell 10 to 18 mm., width 5 to 9 mm. **Aplexa hypnorum**

E. Spire elevated, dextral.

a. Adults under 20 mm. in height, columella without well-marked fold.

aa. Columellar lip not broadly reflected.

1. Rather slender, growth lines numerous with usually some coarser wrinkles, sometimes faceted by a few coarse spiral wrinkles intersecting growth lines, aperture narrow and half the length of shell or more, base rather produced, whorls 5, height 8 to 13 mm. **Lymnæa obrussa**
2. Short spired form of *obrussa* **Lymnæa obrussa modicella**
3. Smaller, spire shorter and less sharp, base less produced than in *obrussa*, whorls 5, height 7 to 9 mm. **Lymnæa humilis**
4. Growth lines fine and numerous, latticed (under lens) by fine, *raised* intersecting spiral lines, whorls 5 or 6, more convex than in *obrussa*, aperture shorter and more nearly circular, height 10 to 15 mm. **Lymnæa caperata**

bb. Columellar lip broadly reflected.

1. More slender than *humilis*, spire longer and more turreted, aperture more regularly elliptical. **Lymnæa parvus**
2. Smooth, shorter than *obrussa* in proportion to height, aperture somewhat longer than *caperata*, growth lines not crossed by spiral raised lines, whorls 5, height 9 mm., width 5 mm. **Lymnæa bulimoides**
3. Spire shorter, form more globose, umbilicus larger than *bulimoides*. **Lymnæa bulimoides cockerelli**
4. Spire acutely conic, whorls 5 or 6, finely striate, usually malleated, facets obliquely descending, umbilicus large, columellar lip very broadly reflected. **Lymnæa bulimoides techella**

b. Adults over 20 mm. in height, with distinct oblique fold across columella.

aa. Very large, whorls 6½, last large and inflated, spreading columellar callus closely appressed, completely covering umbilicus. **Lymnæa stagnalis appressa**

bb. Smaller, whorls 6, last not so large in proportion to spire, columellar callus not entirely covering umbilicus.

1. Growth lines crowded, crossed by numerous fine, incised spiral lines and sometimes several coarse, elevated wrinkles, whorls rather flat, peristome thin, white, with brown band edging callus within. **Lymnæa palustris**
2. Very long spire, whorls flat. **Lymnæa palustris elodes**
3. Body whorl and aperture wider, whorls rounded and somewhat shouldered. **Lymnæa sumassi**

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Catalogue of Colorado Mollusca

[The references are to publications listed in the preceding bibliography, the figures in bold-faced type indicating the number of the publication in the bibliography, the light-faced figures indicating the page. The published records and synonomy appear first, followed by our new records and occasional comments.]

Genus **ANODONTA** (Bruguiere *Em.*) Lamarck

Anodonta grandis gigantea Lea. Pl. I, fig. 1.

Anodonta plana Lea, collected by Mr. Chas. T. Simpson in Lodge Pole Creek, Cockerell **22**, 61.

We find no other other record. *A. plana* has been since placed in synonomy of *A. g. gigantea*, but the validity of the subspecies may be doubted, in which case this record would stand as *A. grandis* Say.

Genus **STROPHITUS** Rafinesque

Strophitus edentulus pavonius Lea. Pl. I, fig. 2.

Strangely enough, this large species does not appear to have been recorded from Colorado, although it likely occurs in all streams of the plains bordering the mountains at least from Denver northward. We have received specimens collected by Prof. A. E. Beardsley in the Cache la Poudre near Greeley, by Prof. D. W. Spangler in the St. Vrain at Longmont, by Prof. E. Bethel in a lake near Denver and have collected them in the Platte near Evans and in the Crow Creek water-holes, 25 miles northeast of Greeley. Some of Prof. Bethel's specimens reached a length of 140 mm.

Genus **ANODONTOIDES** Simpson

Anodontoides ferrussacianus Lea. Pl. I, fig. 3.

Anodonta ferussaciana, collected by Mr. Simpson in Lodge Pole Creek. Cockerell **22**, 61.

Genus **LAMPSILIS** Rafinesque

Lampsilis ventricosa Barnes. Pl. I, fig. 4.

Unio occidens Lea. Collected by Mr. Simpson in Lodge Pole Creek. Cockerell **22**, 61.

Lampsilis anodontoides Lea. Pl. II, fig. 5.

Unio anodontoides. Lodge Pole Creek, Simpson **48**, 430.

Lampsilis luteola Lam. Pl. II, fig. 6.

Unio luteolus, eastern Colorado, Simpson **47**, 88.

Unio tetralasmus camptodon Say. Pl. II, fig. 7.

Four or five specimens were collected by Prof. A. E. Beardsley, in Carrizo Creek, in 1881, but had never been recorded.

Genus **SPHÆRIUM** Scopoli

Sphærium occidentale Prime.

Pond near Black Lake, Cockerell **22**, 65.

Sphærium hendersoni Sterki. Pl. II, fig. 8.

Crow Creek water-holes, Sterki **61***a*, 69.

The type-specimens of this fine, large species were found by the University of Colorado Pawnee Butte expedition. They occur in large numbers in the Crow Creek water-holes

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northeast of Greeley, and have as yet been found nowhere else in Colorado. Dr. Sterki writes: "A species from the Mississippi Valley, etc., may possibly be of the same species, not described so far as I know."

Specimens collected by Prof. Beardsley in the Cache la Poudre, near Greeley, much resemble *S. striatinum* Lam., but the shells are heavier and there are other minor differences. Another lot obtained by the same collector at the head of Rio Grande Canyon, 12 miles from Antonita, Conejos County, do not seem referable to any known species. Further material, especially from other localities, and further study of these two forms are desirable before deciding whether they are new. A few dead shells collected by Prof. E. Bethel near Meeker are near *S. striatinum*.

Genus **CALYCULINA** Clessin

Calyculina partumeia Say.

Sphærium partumeia, Saguache and Rio Grande, Yarrow **68**, 949, 950.

Calyculina securis Prime. Fig. 1 (enlarged +½).

FIG. 1

A few rather small specimens, not quite typical in surface appearance, were collected by Mr. D. M. Andrews in a small lake between Magnolia and Rollinsville, in the mountains west of Boulder. Further specimens from other localities are desirable, to determine whether the variation is constant.

Calyculina rykholti Norm.

Saguache, Sterki **60**, 93. Specimens referred to this European species with hesitation.

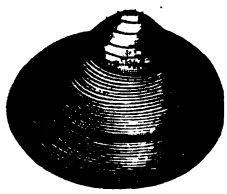

FIG. 2

Genus **PISIDIUM** Pfeiffer

Pisidium abditum Hald. Fig. 2 (very much enlarged).

Hot Springs, Animas Valley and St. Mary's Lake, Ingersoll **35**, 407. Empire, Ingersoll **37**, 134. Middle Lake of the Clouds, Powderhorn and East Fork Surface Creek, Cockerell MSS.

Pisidium noveboracense Prime.

We have obtained a few specimens from a ditch east of Boulder, but they are "small and not characteristic" (Sterki MSS.).

Pisidium variabile Prime.

Rio Grande of Colorado, Yarrow **68**, 951. Custer Co., Cockerell **22**, 64.

Pisidium compressum Prime.

Found by the University Pawnee Butte expedition in a small stream emptying into the Big Thompson near Loveland.

Pisidium friersoni Sterki.

Denver, Sterki **61**, 20.

Prof. Cockerell, to whom Dr. Sterki's specimens were credited, informs me that they were in fact collected by Prof. E. Bethel. We have collected the species from Owen's Lake and ditches east of Boulder and have received a few collected by Prof. E. A. Kenyon at Florence.

The *Pisidia* of Colorado are not sufficiently understood at present. The writer has collected several forms in the mountains west of Boulder, up to an altitude of over 10,000

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feet, which have not yet been satisfactorily worked up. Dr. Sterki, who has examined our material, suggests the importance of thoroughly studying the genus with reference to differences shown by specimens from various elevations. For this purpose large collections from many localities are desirable, each lot from each locality to be carefully kept separate.

Dr. Sterki writes that "a forthcoming monograph of the North American *Pisidia* is expected to give as much in the way of comparison of species with each other as can be given in the present (or then) state of our knowledge," which will be an important contribution, as the original descriptions were evidently not written for comparative purposes.

[*Concluded in next number of these "Studies."*]

EXPLANATION OF PLATES

PLATE I

FIG. 1. *Anodonta grandis gigantea* Lea.

FIG. 2. *Strophitus edentulus pavonius* Lea. *a*, from Denver; *b*, from Greeley.

FIG. 3. *Anodontoides ferussacianus* Lea.

FIG. 4. *Lampsilis ventricosa* Barnes.

PLATE II

FIG. 5. *Lampsilis anodontoides* Lea.

FIG. 6. *Lampsilis luteola* Lam.

FIG. 7. *Unio tetralasmus camptodon* Say. From Las Animas County.

FIG. 8. *Sphærium hendersoni* Sterki. From Crow Creek, photographed from cotypes, the first published figure.

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FIG 2b. × ⅔

FIG. 4b. × ⅔

FIG. 2a. × ⅔

FIG. 1a. × ⅔

FIG. 3a. × ⅔

FIG. 1b × ⅔

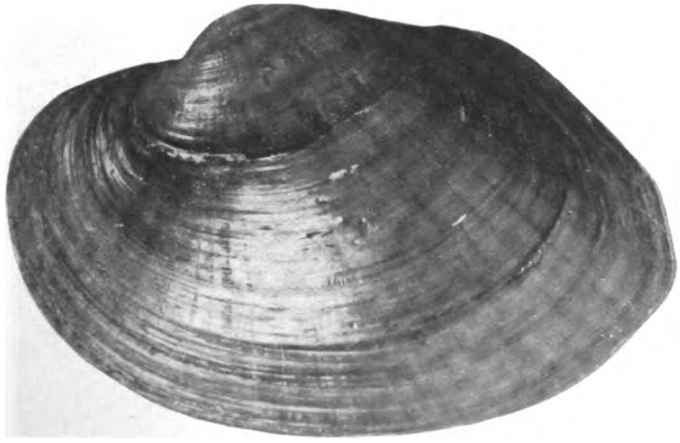

FIG. 4a. × ⅔

FIG. 3b. × ⅔

MOLLUSCA OF COLORADO

PLATE I

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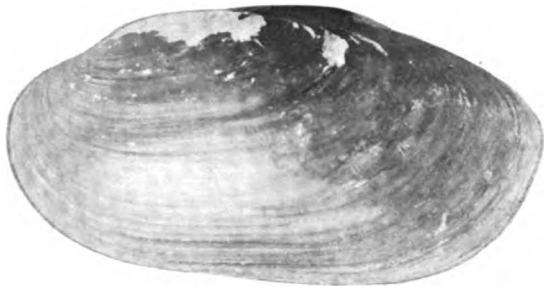

FIG. 5a. × ⅔

FIG 5b. × ⅔

FIG. 6a. × ⅔

FIG. 6b. × ⅔

FIG. 8b. ×1 ⅔

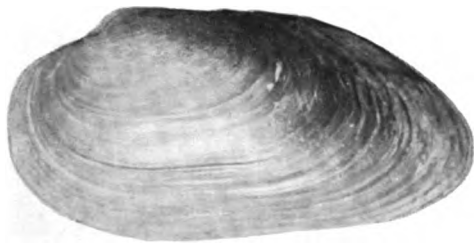

FIG 7a. × ⅔

FIG. 7b. × ⅔

FIG. 8a. ×1 ⅔

MOLLUSCA OF COLORADO

PLATE II

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ON THE BRAIN OF ONE OF THE SALAMANDERS (*Plethedon glutinosus*)

By Gideon S. Dodds'

Introduction

In a former[1] paper the author published an account of the cranial nerves of *Plethedon glutinosus*. In the following pages is given a description of the brain of the same form.

Before entering into the more minute account of the structure of the brain, a few notes of a general nature may be of interest to those without a knowledge of the technicalities of brain structure. *Plethedon glutinosus* is a salamander occurring in the eastern United States. It is chiefly terrestrial in its habits. It measures from 5 to 7 inches in length, the specimens used in this study being about 5 inches long. Such a brain as that of *Plethedon glutinosus* is an excellent example of a brain showing the various parts in simple relations, being in some respects better than the much studied brain of the frog. The brain of *Amblystoma tigrinum*, our common "water dog" in Colorado would be equally satisfactory.

Fig. 17 gives a good idea of the general external appearance of the brain. At first glance, it appears to have nothing in common with such a brain as that of man, but the difference is not so great as might be imagined, for, in such a brain as this one, there are present in simple form, the same parts which make up the brain of the higher vertebrates. The real difference between this brain and that of man is in the relative development of the different parts.

In the brain of higher forms, the enormous relative growth of the cerebral hemispheres has obscured the real structural relations of the different parts. Fig. 17 shows that in this brain, the cerebral hemispheres are not "hemispheres" at all, but instead, two somewhat cylindrical bodies, no more conspicuous than the other parts of the brain.

[1] "The Cranial Nerves of one of the Salamanders (*Plethedon glutinosus*)," *The University of Colorado Studies*, III. 87, 1906.

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Yet these structures are the parts which in man and other mammals comprise by far the greater part of the brain. The *mesencephalon*, which in this brain is quite as conspicuous as the cerebral hemispheres, is the part of the brain which, in all vertebrates below the mammals, forms the optic lobes. In the mammals it forms four inconspicuous bodies known as the *corpora quadrigemina*, hidden away beneath the other parts of the brain. The cerebellum of higher forms, containing the well-known *arbor vitae*, or "tree of life" is represented in this brain by a small band of fibers crossing from one side of the brain to the other. It appears in Fig. 17 just back of the *mesencephalon*. The medulla oblongata, also clearly shown in this figure, shows on the other hand no very marked external differences from that of higher forms. This structure is much more constant throughout the vertebrate series than are the other parts of the brain. It is also of interest to note that the ten pairs of cranial nerves as shown here, both in their distribution and place of origin, correspond quite closely to the first ten of the twelve pairs of cranial nerves found in the human brain.

A study of the drawings made from sections, will give a good idea of the size and arrangement of the ventricles of the brain which also occur here in simple relations. It will be noticed also, that the gray matter, represented by the shaded portions of the drawings, is arranged around the ventricles, and that there is no layer of gray matter placed at the surface to form a cortex as in higher forms.

Methods and Terminology

On account of the small size of *Plethedon*, it was necessary to use microscopic methods in the study of this brain. Entire decalcified heads were embedded in celloidin and sections cut and mounted in series. Various stains were used. Borax-carmine and Delafield's haematoxylin each showed some features clearly. Weigert's haematoxylin (Pal's method) gave the best results for the peripheral distribution of nerves, and iron-alum haematoxylin for internal fiber tracts.

In this paper, so far as applicable, the Basel Anatomical Nomenclature [BNÀ] has been used. In some places, where the homology of the structure seemed doubtful, it seemed better to use some other

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terms rather than to use [BNA] terms of doubtful application. The terms of the [BNA] nomenclature as used here are from the table given by Hardesty ('02) in his "*Neurological Technique.*"

External Features

In external features, the brain of *Plethedon glutinosus* presents no striking differences from that of other Urodela. It resembles most closely that of *Desmognathus fusca* as described by Fish ('95). It measures 7 to 9 mm. in length and 2 to 2.5 mm. in width at the widest part. There is somewhat of a cervical flexure which is corrected by a more decided pons flexure, so that the general contour of the brain is straight. The brain by no means fills the cranial cavity, the relation being shown in Fig. 7.

The widest part of the brain is near the caudal extremity of the cerebral hemispheres, from which place it narrows toward the anterior end of the olfactory lobes. The diencephalon lies between the diverging caudal ends of the cerebral hemispheres. The mesencephalon is of the usual type in Urodela. The metencephalon (cerebellum) appears as a band running around the caudal end of the mesencephalon. The medulla is of the regular type found in Amphibia.

In this study no special attention was given to the meninges and blood supply. So far as observed they agree with the accounts of these features in other Amphibia.

General Morphology

Telencephalon—In this division of the brain are included the cerebral hemispheres and their forward extensions, the olfactory lobes. The cerebral hemispheres are somewhat cylindrical, and smaller in front than near the posterior end. Their caudal ends taper abruptly. Externally the posterior limit of the olfactory lobes is not clearly marked. It was not clear from my observations of the internal structure just where the limit should be placed. The olfactory glomerules lie near the surface of the antero-lateral aspect, somewhat toward the ventral surface. The large olfactory nerves, here as in other Urodela, arise from the antero-lateral angle of the rhinencephalon. The lateral ven-

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tricles extend well forward into the olfactory lobes, and their forward extremities curve inward so as nearly to reach the mesial surface.

In the hemispheres, the lateral ventricles extend the length of the segment. They communicate with the anterior part of the third ventricle by the slit-like interventricular foramen (foramen of Monro) (Figs. 11–16). The lateral ventricles are surrounded entirely by gray matter, and a conspicuous spur, known as Ammon's horn, extends forward from the posterior end of each hemisphere. The pallium is well developed, comprising quite a thickness of gray matter. The striated bodies appear as thickenings on the ventro-median walls of the hemispheres. On the dorsal median line, in the angle between the caudal ends of the hemispheres, appears the choroid plexus of the third ventricle, often called the supraplexus. It drops down into the brain and forms the anterior wall of the third ventricle above and forward of the lamina terminalis. It sends branches forward and backward. The forward extension reaches far into the lateral ventricles.

The lamina terminalis in Amphibia is generally considered as extending from the optic chiasma forward and upward to the choroid plexus. Immediately back of the interventricular foramen, there arises from the lamina terminalis an elevation which comprises the fibers of two commissural bundles (Figs. 10 and 16). The ventral bundle is the anterior commissure, the dorsal one the so-called corpus callosum. In *Plethedon* these bundles are separated at the median line by a single layer of cells, apparently continuous with the gray matter of either side. Almost immediately on either side, the dorsal bundle bends abruptly upward and the ventral one more slowly downward, so that they soon become separated by a considerable amount of gray matter (Fig. 5). The fibers of the upper tract take a course upward and forward to form the posterior and dorsal walls of the interventricular foramen and almost immediately spread out on the median and dorsal walls of the lateral ventricles (Fig. 16).

The question of the true homology of the dorsal bundle is a much debated one. It occurs in other Urodela in much the same relations as in *Plethedon*, and in Anura the conditions are essentially the same. It has quite generally been considered to be the homologue of the callosum.

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The principal paper presenting this view is by Osborne.[1] He considers that there is no doubt that this is a true callosum, and bases his judgment upon a study of *Necturus* and *Proteus*. In these forms he found the dorsal bundle completely separated from the ventral and a fold of the plexus passing between them. Herrick,[2] moreover, recognized the cells here, a clearly defined, continuous film of epithelium separating them. He considers these two points of great value in determining the true relations of the bundle. The chief objection to its being called a callosum had hitherto been, that while the callosum forms the roof of the ventricle, this bundle forms the floor. The conditions observed by Osborne and Herrick are considered to mark the bundle as morphologically belonging to the roof of the ventricle and not to the lamina terminalis.

Other observers consider the conditions observed in these cases not normal. Kingsbury ('95) finds in larval forms of *Necturus*, that the two bundles are separated by several layers of cells, none of which are epithelial, and in twelve adult brains, he finds no separation by cells at the median line. This agrees with the observations of Fish ('95) and Mrs. Gage ('93) on *Necturus* and other forms. Fish does not agree that the tract is dorsal. Nevertheless he considers that it is a true callosum, and that a phylogenetic study clearly shows its homology. He holds that though the tract is of ventral origin, a continuous growth of the hemispheres would cause it to migrate upward and forward in the lamina terminalis until it would come to occupy a position that would approximate that of the callosum in higher vertebrates. To show the actual migration of the bundle, he presents a series of drawings from median sagittal sections from *Desmognathus*, *Cryptobranchus* frog, turtle, and bird. If we consider only the relations at the median line, he seems to make his point. But, as Kingsbury ('95) points out, he ignores the question of the distribution of the fibers as regards the interventricular foramen. The mammalian callosum is in *front* of the foramen and *above* the ventricle. The so-called callosum of Amphibia is *behind* the foramen and *below* the ventricle. "It is evident that however far cephalad and dorsad the terma [lamina terminalis] might be

[1] Kingsbury, '95, p. 154. [2] *Ibid.*, p. 153.

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bent, the relations of Amphibia could only be directly changed into those of higher forms by the migration of the bundle in question across the portas" [interventricular foramens]. (Kingsbury '95, 158.) This peculiar relation, he shows, has either been ignored by other writers or considered of no consequence. He, however, considers the objection a vital one and that the structure under question cannot be homologized with the mammalian callosum, though it may prove to be, in part at least, a hippocampal commissure.

It appears to the writer that we cannot look to a phylogenetic study of adult structures to settle the point in question. The importance of an embryological study seems to be overlooked. It seems highly probable that light would be shed upon this question by a comparative study of the embryology of the structures under discussion. Observations have been made upon larval forms, but no careful study upon early embryos. Work by cytological methods, comparable to that done upon mammalian and chick embryos might prove of great value. As no such work seems to have been done, a brief discussion and a few suggestions, based chiefly upon conditions observed in mammals and birds may be in place here.

The account of the origin of the mammalian corpus callosum as given by Minot ('92, 682) is of interest. Early in embryonic life, "the upper part of the lamina terminalis becomes much thickened to form a broad band of triangular section uniting the two hemispheres. This band is the anlage of the septum lucidum, the corpus callosum, the fornix, and the anterior commissure." At this time there are no fibers connecting the two hemispheres, and in fact, the hemispheres themselves are but slightly developed. The anlage of each of these commissures can be distinguished as a distinct area in this structure. Later, the fibers of these commissures grow across the median line from each side toward the opposite side through their respective areas. Thus we see that the corpus callosum, in its origin, belongs to the lamina terminalis and is not a dorsal structure as held by some writers. The callosum in birds and mammals arises in the lamina terminalis in a position homologous to that occupied by the "callosum" in adult Amphibia. Mrs. Gage's figures 66 and 67, from median sections of embryo *Diemyctylus*

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indicate that the origin of these commissures in this form is essentially the same as in higher vertebrates. In an embryological study, the course of the fibers with reference to the interventricular foramen must be considered. A comparative study of embryos may show that the transition from one condition to the other does not involve the supposed difficulties. To bring about such a change of relations we do not need to consider the fibers of the bundle as migrating across the foramen. The place of appearance of the anlage of these commissures varies somewhat in different forms. In birds and mammals it is *in front* of the foramen, while from Mrs. Gage's figures, already referred to, it appears that in Amphibia it is *below* the foramen. Now, it seems reasonable to suppose that in one case the fibers arising in a given part of the anlage, grow across above the ventricle and in front of the foramen and in the other case below the ventricle and behind the foramen. Thus the change of conditions might easily come about without the migration of the bundle as such across the foramen. To determine whether this is actually the case and clearly to identify the anlage of the "callosum" of Amphibia with its homologue in higher forms are questions for comparative embryology.

Diencephalon.—There is no marked line of separation between this segment and the mesencephalon. On the dorsal surface of this segment, at its forward extremity, appears the choroid plexus, which dips down and shuts off the cavity of the mesencephalon from the longitudinal fissure. In its folds lies the paraphysis. Just back of this are the habenulae and supracommissure, and just back of this the pineal body. The conspicuous features on the ventral surface are the large infundibulum and the hypophysis. The optic chiasma, at the forward limit of the diencephalon, lies sunken in the surface and makes no prominence. In this segment the cavity of the brain has its greatest dorsoventral expansion but is of narrow lateral dimensions. Just in front of the chiasma, on either side, it expands into a narrow pocket, known as the preoptic recess, representing the primitive lumen of the optic vesicle. The ventricle sends off a ventral spur which enters the infundibulum by a narrow passage and then expands laterally to a considerable width. The dorsal and posterior wall of the infundibulum is

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composed of the pia and a single layer of epithelium. The hypophysis is closely applied to this. It is of two parts, a dorsal and a ventral, separated by a constriction (Figs. 10 and 16). The anterior part of the dorsal division is of a different nature from the rest of the body. Its exact structure was not clear in my sections. The rest of the organ is of a glandular structure. In the diencephalon, the choroid plexus divides into two main branches; a ventral one extending toward the cavity of the infundibulum, and a dorsal one extending backward into the cavity of the mesencephalon as far as the cerebellum.

In the roof of the diencephalon, just back of the choroid plexus, are the habenulae, and closely associated with them the supracommissure. Immediately back of the habenulae, the dorsal wall of the brain becomes thinned, till it consists of only a single layer of epithelium. Lying just above this is the pineal body. It is a very much flattened sac of one or two layers of cells. There is a distinct cavity, but it has no connection with the cavity of the brain, though the thinning of the wall of the brain at this place no doubt represents the pineal recess, the primitive lumen of the organ. In the lateral walls of the diencephalon are indefinite gatherings of gray substance, but no distinct optic thalami.

Mesencephalon.—The anterior boundary of this segment on the dorsal surface is generally considered to be just in front of the posterior commissure, and on the ventral surface, just forward of the origin of the third nerve. As has been found to be the case in other Urodela in distinction to the condition in Anura, there is no dorsal separation of this segment into a pair of gemina. The roof is nearly circular in outline and somewhat flattened. The cavity of the brain in this segment expands laterally to a considerable width, but decreases greatly in height. Backward it narrows again and leaves the segment as a narrow passage. The gray matter of the roof shows separation into two layers, as is common in Urodela. The posterior commissure crosses, deeply intrenched in the gray matter of the roof and sides of this part of the brain. The external layer of white matter of the dorsal and lateral portions of the mesencephalon contains the optic fibers. These course forward and downward over the sides of the diencephalon to form the optic tract (Figs. 11–15).

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Metencephalon.—The cerebellum is an inconspicuous part of the brain. It curves around the posterior surface of the mesencephalon, and is composed chiefly of white matter. It comprises the fibers of two commissures. A single layer of cells surrounds the white matter. Its appearance on the dorsal surface of the brain is shown in Fig. 17, and its appearance on transection in Figs. 10 and 16.

Myelencephalon.—This part of the brain is of the usual Amphibian type. The fourth ventricle is covered by a choroid plexus. The cranial nerves from the fifth to the tenth arise from this segment. The gradual transformation from medulla to spinal cord takes place in the usual way.

Fiber Tracts

In the Amphibian brain, several well-defined fiber tracts are clearly recognizable. Some of these can be pretty satisfactorily homologized with structures in higher vertebrates while the homologies of others are doubtful. Regarding the names applied to some of these there is also no very great agreement. The terms used in the following description, are, so far as could be determined, those most generally used.

Posterior longitudinal fasciculus.—The fibers of this tract can be distinguished as a well-marked bundle in the ventral part of the medulla (Fig. 8). Thence they pass forward into the mesencephalon, where they cannot longer be distinguished as forming a definite tract.

Basal prosencephalic tract.—The fibers designated by this name form a tract which has been described under various names. Kingsbury ('95) uses the term adopted here. This was used before by Edinger. In sagittal sections it appears to be a forward continuation of the posterior longitudinal fasciculus, though the fibers are probably not continuous. In cross-section it appears as a very definite bundle on either side of the median line (Figs. 5 and 6). Beginning well back in the mesencephalon, it can be traced forward into the ventral part of the hemispheres. The fibers of this bundle are mostly non-medullated.

Anterior commissure.—This commissure is composed chiefly of non-medullated fibers, and by the methods used, it could not be traced very satisfactorily. The main bundle on either side of the median line inclines slightly downward and then passes forward just below the basal

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prosencephalic tract. The two bundles soon become indistinguishable as separate tracts. Probably a part of this tract turns backward, but this could not be very definitely determined. This part is commonly present in Amphibia. Medullated fibers enter the commissure from the basal prosencephalic tract from before and from behind. They may possibly be decussating fibers.

"*Corpus callosum.*"—The tract designated by this name has been fully described elsewhere. The term corpus callosum is probably not a proper one for this structure, as it more likely represents a hippocampal commissure. However, it is simpler, and less likely to lead to confusion, to use the old term till we have sufficient knowledge of the structure to apply a fitting new one. In *Plethedon* the fibers of this tract are chiefly non-medullated.

Supracommissure.—In the region of the habenulae, in sagittal sections, three separate bundles can be distinguished crossing the median line (Fig. 10). The most anterior of the three occupies a position at the very forward part of the habenulae. It is by far the smallest of the bundles. It could not be traced for any considerable distance. It is probably composed of commissural fibers between the habenulae of the two sides. It may possibly represent the commissura habenularis (Edinger, '99, p. 126 *et seq.*). In accounts of other Urodelan brains, so far as I have been able to learn, only two bundles are described at the median line. The other two bundles correspond to the supracommissure as described for other Urodela. These two bundles on either side of the median line, soon unite, at least apparently, into one bundle. Probably, however, the two parts really remain distinct. The bundle passes in a ventral direction on either side, and soon, from its posterior part fibers begin to be given off backward; finally a quite distinct bundle passes backward into the diencephalon. The remainder of the bundle, probably representing the middle part at the median line passes forward and outward into the hemispheres.

Meynert's bundle.—The bundle generally described under this name in Amphibia is the tractus habenulo-peduncularis described by Edinger. ('99, pp. 131, 132 and 306). In *Plethedon*, as in other Urodela, it is a compact bundle of non-medullated fibers. It arises from the habenulae,

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just back of the supracommissure. Its fibers at first take a course backward and a little downward as a loose bundle. Then turning more directly ventralward they form a small but compact bundle. Near the ventral surface of the brain, the bundle again turns backward and ends in the gray matter on either side of the median line, just in front of the origin of the third nerve (Figs. 12–15).

Posterior commissure.—The fibers of this commissure cross deeply intrenched in the gray matter of the mesencephalon some little distance back of Meynert's bundle (Figs. 11–14). They take a course downward and backward as a quite definite tract of medullated fibers, but the tract soon becomes less compact, so that its relations could not be determined.

Cerebellum.—As before stated, two bundles of fibers can be distinguished, a ventral one and a dorsal one. The ventral bundle is the smaller of the two and its fibers curve forward into the mesencephalon. The fibers of the dorsal bundle pass backward into the medulla. A fold of the pia separates this bundle from the mesencephalon.

Mauthner's fibers.—These are not very distinct, but fibers probably representing them, can be distinguished in the ventral part of the cord and medulla. They were not traced to their termination in the medulla. In my sections one of these fibers is much larger than the other one.

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Description of Figures

Figs. 1–9 are from cross-sections of the brain in order from before backward. They are not cut directly across the brain, so that the two sides are somewhat different. Magnification × 25.

Figs. 1, 2.—Through the olfactory lobes.

Figs. 3, 4.—Through the cerebral hemispheres.

Fig. 5.—Through the cerebral hemispheres and the diencephalon.

Fig. 6.—Through the diencephalon.

Fig. 7.—Through the mesencephalon, showing the brain in place in the cranium.

Fig. 8.—Through the medulla at origin of the auditory nerve.

Fig. 9.—Through the spinal cord just back of the medulla.

Figs. 10 and 16 are from sagittal sections. Magnification × 12. Fig. 10 shows the parts of the brain as they would appear in a median sagittal section. This drawing was made by comparison of a number of sections from different brains. Fig. 16 is from a nearly sagittal section a little to one side of the median line. This shows especially the relation of the fibers of the corpus callosum to the interventricular foramen.

Figs. 11–15 are from frontal sections in order, from the dorsal toward the ventral side of the brain. Magnification × 12. The sections are cut a little lower on one side than the other. They give a good idea of the size and arrangement of the ventricles of the brain.

Fig. 17 is a dorsal view of the entire brain, ×12.

Reference Letters

I–X, the cranial nerves.
Ah., Ammon's horn.
ant. com., anterior commissure.
bpt., basal prosencephalic tract.
cal., corpus callosum.
ch. pl., choroid plexus.
cord, spinal cord.
dien., diencephalon.
Gg., Gasserian ganglion.
go., olfactory glomerules.
hyp., hypophysis.
int. f., interventricular foramen.
inf., infundibulum.
lam. t., lamina terminalis.
Mb., Meynert's bundle.
med., medulla oblongata.
mesen., mesencephalon.
meten., metencephalon.
Mf., Mauthner's fibers.
o. ch., optic chiasma.
of., optic fibers.
pb., pineal body.
p. com., posterior commissure.
plf., posterior longitudinal fasciculus.
pr., preoptic recess.
rhinen., rhinencephalon.
spcom., supracommissure.
striat., corpora striata.
telen., telencephalon.
v. lat., lateral ventricle.
v. 3, third ventricle.
v. 4, fourth ventricle.

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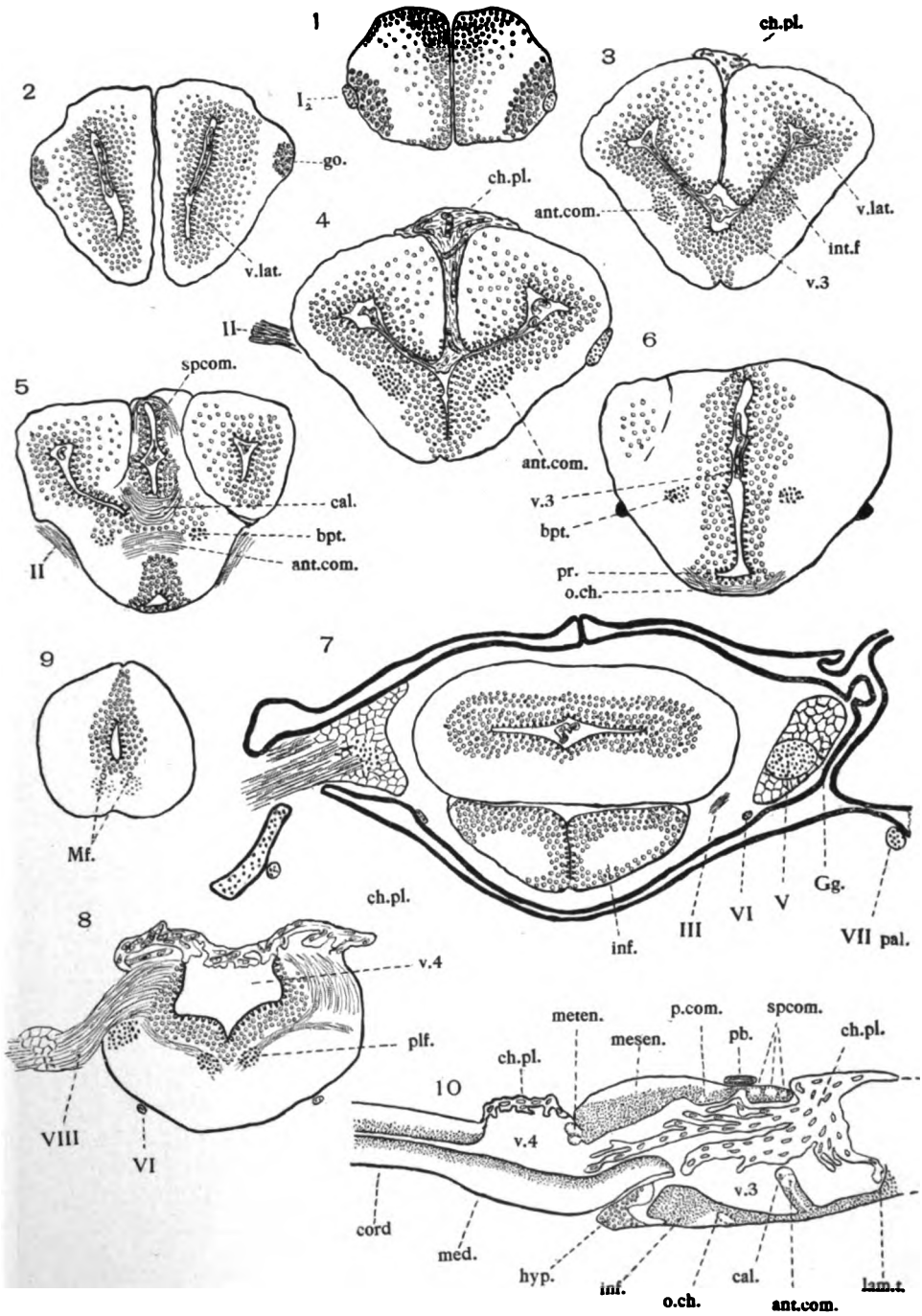

THE BRAIN OF PLETHEDON GLUTINOSUS
PLATE I

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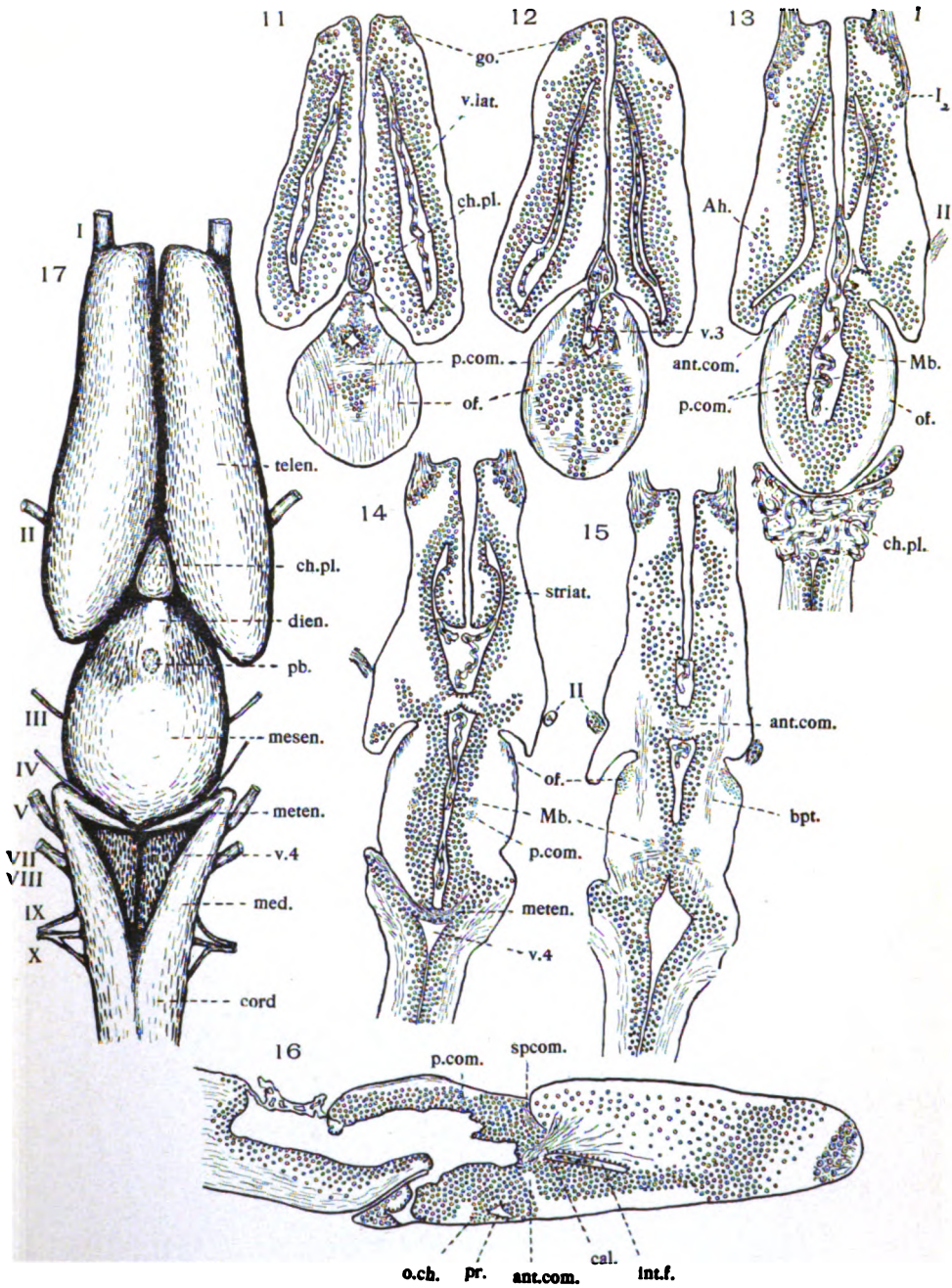

THE BRAIN OF PLETHEDON GLUTINOSUS
PLATE II

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THE SILVA OF COLORADO[1]

I. Trees of the Pine Family in Colorado

By Francis Ramaley

Our principal forest trees.—The trees of the pine family are of such value to Colorado that some account of them should be useful. The early settlers used native wood for fuel before coal was mined; and native pine and spruce furnished the material for building purposes and for mine timbers. Even at the present time a considerable amount of timber is being cut in all our mountian counties. Aside from the pines, spruces and firs there are few trees of economic value in the state. Along the rivers and creeks the various cottonwoods and willows occur. On the mesas and foothills west of the front range there are in many places large groves of quaking aspen, but all of these trees are used chiefly for firewood and not for lumber as are the pines and spruces.

The value of forests is not merely in the lumber which may be cut from them. In all mountain regions forests are needed for protection. A protection forest saves the soil from being washed away,[2] it prevents too rapid melting of snow and consequent floods and it provides steady stream-flow for irrigation in the lowlands. Without forests on our hills and mountains there could be little agriculture in Colorado. Wherever mountain forests are dense the soil is deep and, retaining moisture for a long time, furnishes the streams with a constant supply of water doled out little by little through the season.

Some economic considerations.—Large areas in the foothills and in the mountains of Colorado can never be used for agriculture or for mining. If they are to be made productive they must be allowed to grow up with trees. Fires must be kept down and the forests protected from injury of all kinds. Many of the partly denuded hillsides can be clothed with timber in thirty or forty years. The time is coming soon

[1] This paper is one of a series which will deal with the trees and shrubs of Colorado.

[2] As is well known, France and other European countries have suffered severely from deforestation of mountain slopes. Not only have the hillsides been denuded of soil but much of the lowland country has been ruined by the sand and gravel washed down upon it.

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when the value of timber will be much greater than it is now. It will pay individuals and corporations to grow trees for the market. Despite the opening up of new coal mines and the employment of brick, stone and metal for building purposes the use of lumber is on the increase. Thus between 1880 and 1900 the population of the United States increased 52 per cent., but during the same time the annual cut of lumber increased 94 per cent. While the annual cut in the last few years is probably not much greater than in 1900, the value has increased considerably and it is to be expected that the rise in price of all wood products will continue indefinitely. A few years ago the northern white pine furnished one-half of all the lumber used in the United States. Now only about 15 per cent. of the annual cut is from this species. The southern hard pines and the Douglas spruce, or "red fir," as well as the redwood of the Pacific coast are being more and more extensively used.

Our native trees may be a source of wealth.—In Colorado the Douglas spruce is native, growing in canyon bottoms and on moist hillsides. With proper protection of the young trees and the carrying-out of a scientific forest policy this species may furnish in future much valuable timber. The rock pine, or "western yellow pine," and the Engelmann spruce will become important. Even the lodgepole pine can be made useful for many purposes when proper methods of seasoning are employed and if suitable treatment is used to prevent decay. The pinyon pine makes excellent charcoal and is a good fuel.

Forests as places for recreation.—Aside from the value of our coniferous forests for protection of watersheds and as a source of timber for mines and for building purposes, they form a valuable asset in attracting tourists to the state. The forests of the mountains form important recreation grounds which are being used by our own citizens and by summer visitors. Each year the number of tourists is greater than the year before and each year more money is brought into the state just because of our mountains and our forests. Indeed, without trees our mountains would offer slight attraction to visitors. I take the liberty of quoting the following from an address by the well-known student of nature, Mr. Enos A. Mills, of Estes Park, Colo.:

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People are feeling the call of the wild. They want the wild, wild world beautiful. They want the temples of the gods, bits of the forest primeval, the pure and fern-fringed brooks. They like to stand "knee-deep in June," they demand the shadow of the pines, and have them they will. Above Colorado's purple forests there are alpine meadows bannered with rare blossoms, and crags and snow go up into the blue. Timber line tells stirring stories of the forest frontier. The sunny grass plots in the forest are delightful wild gardens with flowers, crags, and brooks that shine in silver. There are still bits of dark forest in which one may hear the music of the pines and the songs of white cascades.

Forest reserves in Colorado.—What the officers of the United States forest service think of the necessity for forests in Colorado may be learned form the extent of the reserves established in the state.[1] On December 31, 1905 there were fourteen such reserves with a combined area of nearly thirteen million acres, or about one-fifth the total area of the state. California is the only state with a larger area of forest reserves. Lumber to the amount of seventeen million feet was sold from the Colorado reserves during 1905. In addition there were ten thousand cords of fuel wood and fourteen thousand posts and poles. In the future, with suitable protection against fire and scientific regulation of lumbering operations the reserves may be expected to furnish a much larger output.

"The Silva of Colorado."—Under this heading it is proposed to publish from time to time articles dealing with the trees and shrubs of the state. Some of the articles will have to do with botanical questions relating to particular trees; some will discuss forest areas; some will be strictly technical; some will be intended for popular use. In the following pages are given descriptions of trees of the pine family. By means of keys and also through the introduction of figures it is hoped to make plain the differences between the species, and to make it possible for persons without botanical training to distinguish these trees when growing in the forest.[2] For most purposes a comparison of the tree with the account in the following keys will be sufficient; rather full descriptions are, however, given for the use of students.

Books dealing with the trees of Colorado.—The greatest work on

[1] *Yearbook of Dept. of Agriculture for 1905*, pp. 636–644.

[2] For certain points in the following descriptions the writer is indebted to D. M. Andrews, Esq., of Boulder, Colo.

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North American trees is the *Silva of North America* by Chares Sprague Sargent, in thirteen folio volumes. The cost of this work, however, makes it impossible for any but the wealthiest individuals and institutions to own it. A short work in one volume by the same author is very serviceable. It is the *Manual of the Trees of North America.*[1] This book contains illustrations of leaves and fruit of every tree known to grow in North America north of Mexico. General works on botany also contain descriptions of trees. Coulter's *Manual of the Botany of the Rocky Mountain Region,*[2] issued many years ago, is the book most accessible since it is found in every high-school library. Unfortunately the tree descriptions there given do not correspond exactly with the species as recognized today. A useful little book is Professor Aven Nelson's *Key to the Rocky Mountain Flora,*[3] in which short but accurate descriptions of most of our trees are given. Very useful to the trained botanist is Rydberg's *Flora of Colorado,*[4] recently issued. Another important work is a "Report on the Forest Conditions of the Rocky Mountians" by various authors issued as *Bulletin No. 2 of the Forestry Division of the United States Department of Agriculture.* The second edition of this bulletin was issued in 1889. Professor Sargent's "Report on the Forests of North America" prepared for the Tenth Census[5] contains much information in regard to the commercial value of different trees. Many of the native trees of the Rocky mountain region were first described in the accounts of the early expeditions conducted by the United States government but this material is now gathered in later publications so that reference to these works is not necessary.

The Pine Family.—As here limited the pine family in Colorado (Pinaceae) includes the pines, spruces and firs. All bear true cones which become hard and dry, never berry-like as in the junipers and cedars. In addition to the seed-bearing cones there are the pollen-bearing cones which produce the pollen spores in the spring. These are smaller cones; when the pollen has been shed they soon wither

[1] Boston: Houghton, Mifflin & Co., 1905, pp. 826.

[2] New York: American Book Co., pp. 452.

[3] New York: D. Appleton & Co., 1902, pp. 94.

[4] *Bull. 100, Agr. Exp. Sta. Colo. Agr. College,* Fort Collins, Colo., 1906, pp. 447.

[5] *Tenth Census of the United States,* Vol. IX, pp. 612.

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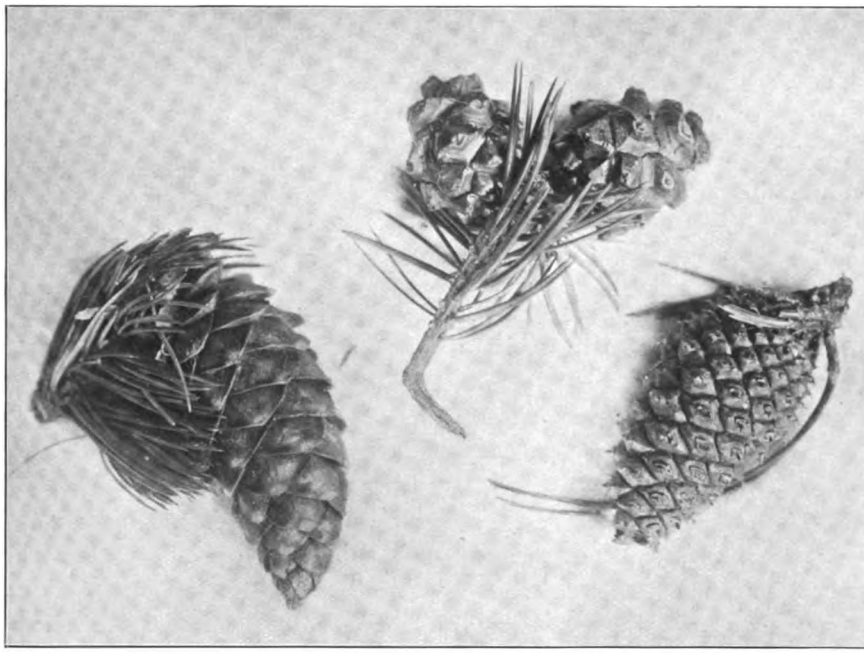
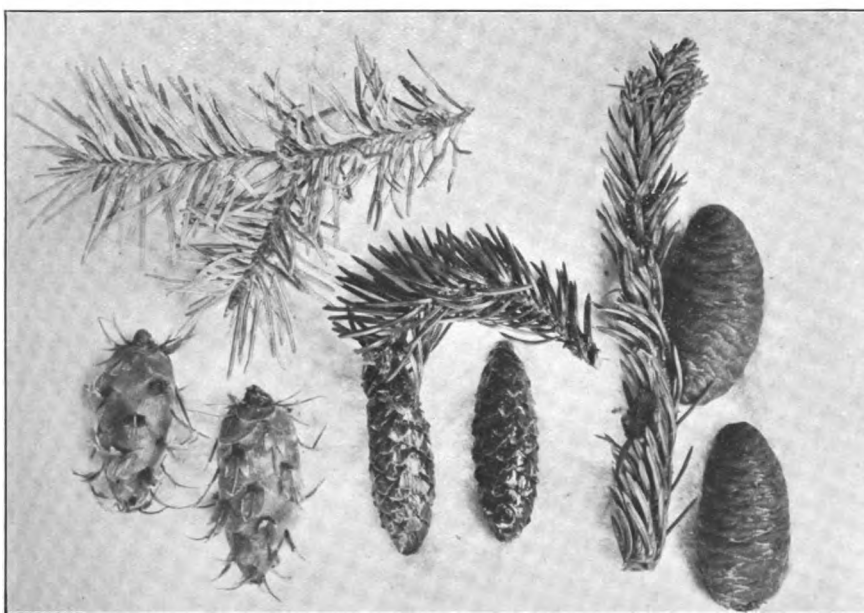


Pinus flexilis × ⅔ Pinus edulis × ⅔ Pinus scopulorum × ⅔



Pseudotsuga mucronata × ⅔ Picea engelmanni × ⅔ Abies lasiocarpa × ⅔

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and dry up so that they are not seen except in spring and early summer. Members of the pine family are easily recognized by the needle-like leaves. The Colorado species, and in fact nearly all cone-bearers are evergreen. This condition is, however, not an essential in the family, for the larches, or tamaracks, of the northern states are deciduous. Throughout the northern hemisphere the pines and their allies are the most important of all woods for building purposes. The wood of the true pines is the most generally used. Two distinct kinds of pines are recognized, viz.: the hard pines or "yellow pines" and the soft pines, "white pines." Douglas spruce ("red fir" "Oregon pine") has wood resembling the hard pines in quality. Firs and true spruces have inferior wood. In fact, the wood of trees in the highest mountains is generally not strong but light and brittle. This fact is easily understood when it is known that the hard part of wood is that formed in the summer. Tropical woods are often hard and heavy. Trees of mountain tops—the spruces and firs—do not exist in conditions of summer and hence do not develop hard and strong wood. Spruce is, however, valuable as a source of wood pulp for making paper. The wood of all the trees of the pine family is known as "non-porous" because there are no vessels, or "pores" in it. Like the hardwoods it is most durable when "quarter-sawed."

Species of the pine family in Colorado.—Ten species are known in Colorado. Of these there are five[1] pines, two true spruces, one Douglas spruce and two firs. The four genera are easily distinguished and it is not difficult to recognize most of the species. However, very few residents of the state and still fewer visitors know them apart. In fact it is quite common to hear them all called pines. It is hoped that the following keys and descriptions will be useful to those interested. There is no good reason why miners, engineers and citizens generally should not know our forest trees.

How to use the key and descriptions.—First be sure that the specimen to be examined is one of the pine family (with needle leaves). These keys and descriptions do not include any account of the junipers

[1] RYDBERG in the *Flora of Colorado* credits the state with one more species of true pine, but I have omitted a description of it since its occurrence is somewhat doubtful.

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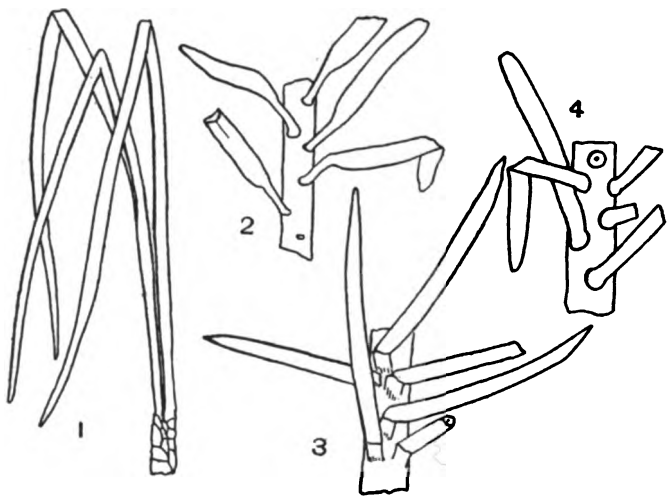
and cedars; they have flat scale-shaped leaves. Now with specimens of the twigs and cones at hand turn to the "Key to the Colorado genera of the Pine Family" on p. 115. Read what is given after **A** and after **B**. If the specimen agrees with the description **A** it belongs to the genus *Pinus*, the pines, and the particular species may be learned by a study of the key to that genus on p. 116. If the specimen is not a pine it will be described by the paragraph **B**. In that case read **a** and **b**. If the description **a** is satisfactory the specimen is a true spruce of the



LEAVES OF THE DIFFERENT GENERA
1. *Pinus;* 2. *Pseudotsuga;* 3. *Picea;* 4. *Abies.*

genus *Picea* and the species may be determined by a study of the key to that genus. In like manner, if the specimen belong to either of the other genera, that fact will be apparent on reading down the key; reference may then be made to the appropriate key for fuller information and for determination of the particular species. Sometimes it is impossible to secure cones but even then the genus may be determined and the tree identified as a pine, spruce, Douglas spruce or fir. In fact the species itself may usually be told without the cones, especially when the tree is a typical one of its species.

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Family PINACEAE,[1] PINE FAMILY

Trees and shrubs with needle-like foliage leaves; usually resinous. Flowers appearing in spring, strobillate. Staminate strobili relatively small, consisting of numerous microsporophylls borne on an elongated axis, the pollen sacs producing a large quantity of pollen. Carpellate strobili consisting of spirally arranged cone scales each accompanied (in most cases) by a bract which is shorter or longer than the scale. Cone scales becoming woody or papery at maturity. Seeds with straight embryo embedded in copious endosperm.

KEY TO THE COLORADO GENERA OF THE PINE FAMILY[2]

A. Foliage leaves (needles) in bundles of two or more surrounded at base by a short sheath. Leaves mostly more than 25 mm. (1 in.) long. Cones hard and woody when mature. 1. Genus **Pinus**
(See the Key on p. 116)

B. Foliage leaves (needles) solitary, not in bundles; mostly less than 25 mm. (1 in.) in length. Mature cones leathery or papery; not hard and woody.

a. Leaves jointed near the base, the lower part of the leaf brown and woody and remaining on the branchlet after the rest of the leaf has fallen. Leaves in our species stiff and four angled, not flat. Cones pendulous. 2. Genus **Picea**
(See the Key on p. 119)

b. Leaves not brown nor woody at base, flat. When they fall off they they leave a scar but no part of the leaf remains.

a' Leaves rather soft; narrowed toward the base into a short stalk which broadens slightly at the point of attachment. Leaf-scars transversely elliptical. Cones pendulous, the projecting bracts three-pointed. 3. Genus **Pseudotsuga**
(See the Key on p. 120)

b' Leaves somewhat stiff, not narrowed at base; leaf scars rather large, circular in outline. Cones erect, dark purple or blackish or sometimes yellow. 4. Genus **Abies**
(See the Key on p. 122)

Genus PINUS, THE PINES

Evergreen trees and shrubs, growing often in dry and rocky soil; wood of most species valuable for timber. Bark thick and furrowed. Foliage leaves needle-shaped, in bundles usually of 2 to 5 leaves or in some species 6 or 7; rarely single. The foliage leaves are borne on very short twigs (dwarf shoots), which arise in the axils of appressed scale leaves and are surrounded at the base by a short sheath. Flowers monosporangiate; the staminate clustered at the base of leafy shoots of the same year. Stamens (microsporophylls) very many, spirally arranged. Car-

[1] In addition to the works previously cited the author has consulted for the technical descriptions *A Handbook of the Trees of California* by Miss ALICE EASTWOOD and "The Conifers of Vancouver Island," by F. K. BUTTERS in *Postelsia*, the yearbook of the Minnesota Seaside Station, pp. 135–212, 1906. For the use of a copy of the former book he is indebted to Miss Eastwood and to Miss Alice Phelps, a student of the University of Colorado.

[2] The cedars and junipers are not included here. A later paper will be devoted to them.

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pellate flowers solitary or clustered. Cone scales thick, becoming woody; bracts short in comparison with the scales. The cones ripen the second year or later. The genus Pinus is widely distributed throughout the northern hemisphere and extends to the Philippine Islands and Sumatra. In the United States and British North America there are about 36 species.

Key to the Colorado Species of the Genus Pinus

A. Leaves in bundles of 4 to 6; medium sized or small trees, chiefly in high altitudes.
   a. Leaves 25 to 40 mm. (1 to 1⅝ in.) long. Cones 7 to 9 cm. (2¾ to 3½ in.) long, the scales with curved, needle-pointed spines. **1. Pinus aristata**
   b. Leaves 3.5 to 7.5 cm. (1⅜ to 3 in.) long. Tree of wind-swept mountain sides or exposed points. Cones large, 7 to 25 cm. (2¾ to 9¾ in.) long, the scales smooth, without spines. **2. Pinus flexilis**

B. Leaves in bundles of 2 or 3.
   a. Leaves short, 2 to 4 cm. (¾ to 1½ in.) long generally in pairs; cones small, about the same length as the leaves, seeds large (about the size of a common white bean), edible. A tree or shrub found in the foothills south and west. **3. Pinus edulis**[1]
   b. Leaves longer, 4 to 12 cm. (1½ to 4¾ in.) long; in bundles of 2 or 3.
      a′ Leaves usually about 10 cm. (3⅞ in.) long, but shorter in exposed situations; sometimes longer. Cones 6 to 9 cm. (2⅜ to 3½ in.). A tree of foothills and river bluffs and extending to an altitude of 10,000 ft. **4. Pinus scopulorum**
      b′ Leaves 3 to 6 cm. (1¼ to 2⅜ in.) long; cones about same length as leaves. A tree of foothills and mountains, often forming pure forests at altitudes of 7,000 to 9,000 ft. **5. Pinus murrayana**

Pinus aristata Engelm. Bristle-cone Pine

Rydberg, *Flora Colo.* 7; Coulter, *Manual* 432 (as *P. balfouriana*, var. *aristata*); Sargent, *Manual Trees of N. A.* 9.

Leaves in bundles of 4 or 5, dark green, 2.5 to 4 cm. long. Staminate flowers dark orange-red; carpellate dark purple. Cone 7 to 9 cm. long. Cone scales somewhat thin, each with a slender curved bristle about 6 mm. long. Seeds winged.

A bushy tree of small or medium size with the main trunk short, numerous strong branches starting rather low down. Bark thin, pale or milky white on small branchlets, dark gray or brown on the main trunk. Wood soft and not durable; specific gravity 0.5572. Sometimes used for fuel. Formerly much employed in central Nevada for mine timbers but the supply is now nearly exhausted.

Rocky and gravelly slopes at high altitudes in the mountains from central and southern Colorado to Utah, Nevada, southern California and Arizona.

[1] A related species, *Pinus monophylla*, differing in having the leaves single, is reported in Rydberg's *Flora of Colorado* from Manitou. The species, is however, usually considered to range west of Colorado.

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Pinus flexilis James. LIMBER PINE, ROCKY MOUNTAIN WHITE PINE

RYDBERG, *Flora Colo.* 8 (as *Apinus flexilis*); COULTER, *Manual* 431; SARGENT, *Manual Trees of N. A.* 7; NELSON, *Key to Rocky Mountain Flora* 6.

Leaves in bundles of 5; stout, rigid, dark green, 3.5 to 7.5 cm. long. Staminate flowers reddish, the carpellate bright red-purple. Cone very large, 7 to 25 cm. long. Cone scales smooth, without bristle points. Seeds with a narrow wing which usually adheres to the cone scale when the seeds drop.

A small or medium-sized tree with a short main trunk and abundant lateral branches, growing in wind-swept situations and hence often much distorted. Bark of twigs and branches pale gray or whitish, becoming dark brown on older trunks. Wood light; specific gravity 0.4358; sometimes used for lumber which is, however, full of knots. This species was discovered in 1820 by Dr. Edwin James, of Major Long's exploring party, near the base of Pike's Peak.

Eastern slope of Rocky mountains from Alberta to western Texas, westward through Montana to Nevada and California. It is the principal tree of the upper foothills of the eastern slope in Montana. In Nevada it forms extensive forests. In Colorado and Wyoming it is usually scattered in exposed situations at rather high altitudes.

The limber pine has not been extensively planted as an ornamental tree but has done well where tried. In cultivation it has a handsome, rather symmetrical form.

Pinus edulis Engelm. PINYON, NUT PINE[1]

RYDBERG, *Flora Colo.* 8 (as *Caryopitys edulis*); COULTER, *Manual* 432; SARGENT *Manual Trees of N.A.* 11; NELSON, *Key to Rocky Mountain Flora* 5.

Leaves in bundles of 2, rarely 3; dark green, curved, stiff, 2 to 4 cm. long. Flowers dark red; the staminate in elongated clusters, the carpellate short stalked. Cone when mature about the same length as the leaves and nearly spherical; cone scales few, thick, spiny tipped. Seeds large, about the size of a small white bean, the narrow wing of the seed remaining adherent to the cone scale when the seed falls.

A small or medium-sized tree, much branched and shrublike. Bark rather thin; that of young branchlet's orange colored, becoming at length gray or brown. Wood rather durable; specific gravity 0.6388; brittle, close grained. Used for fuel and fencing and sometimes for preparation of charcoal. In western Texas it has been sawed for lumber. The large, edible seeds, collected by Indians, are on sale by fruit dealers in the towns and cities of Colorado.

Eastern foothills of the outer range of the Rocky Mountains from near the Palmer Lake divide south to western Texas and west to Arizona and southwestern Wyoming. At the head of the Arkansas it forms open forests with the rock pine; mixed

[1] The author is indebted to Professor E. A. Kenyon, of Florence, Colo., for fresh material of this species from which photographs were made.

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with junipers it is common on the hills and table lands of western Colorado. It does not occur at very high altitudes.

Pinus scopulorum (Engelm.) Lemmon. ROCK PINE, WESTERN YELLOW PINE

RYDBERG, *Flora Colo.* 7; COULTER, *Manual* 432 (as *P. ponderosa*, var. *scopulorum*); SARGENT, *Manual Trees of N. A.* 15 (as *P. ponderosa*, var. *scopulorum*); NELSON, *Key to Rocky Mountain Flora* 6.

Leaves in bundles of two or three, variable as to number even on the same tree; stout, dark yellowish-green, often in bottle-brush arrangement at the ends of naked branches; 8 to 15 cm. long. Staminate flowers yellow; carpellate dark red. Cone 6 to 9 cm. long, the cone scales each with a stout sharp prickle. The young cones are erect the first summer; when fully grown they are horizontal or slightly declining.

A handsome spreading tree, the largest of our pines, with thick deeply-furrowed, reddish bark becoming very thick on old trees. Wood hard and strong but differing greatly in quality; where abundant it is sawed into lumber or used for railway ties and mine timbers. The specific gravity is 0.4619.

Hills and ridges of western Nebraska to Rocky Mountain region and from Montana to Arizona and New Mexico, forming on the Colorado plateau the most extensive pine forests of the continent.

On account of its resistance to drought this tree should be a valuable one for planting in semi-arid districts. The large seeds germinate freely and the trees are easily grown when given reasonable care.

Pinus murrayana "Oreg. Com." LODGEPOLE PINE

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 433 (as *P. contorta*, var. *murrayana*); SARGENT, *Manual Trees of N.A.* 27 (as *P. contorta*, var. *murrayana*); NELSON, *Key to Rocky Mountain Flora* 5.

Leaves in bundles of 2, yellow-green, 3 to 6 cm. long. Staminate flowers orange-yellow, carpellate reddish. Cone about the same length as the leaves, very persistent, often remaining attached three or four years after ripening; cone scales with short, sharp prickles. Seeds winged.

A tall, straight tree, generally growing in dense groves on north slopes in the foothills. The trees have been considered of little value for lumber but they are certainly most useful in holding the soil and in protecting snow from too rapid melting. Seeds of this pine, unlike those of most species, retain their vitality for a number of years. Burned districts become reseeded by the opening of the cones which takes place on account of the heat produced by the fire. Wood rather light and soft, not durable; specific gravity 0.4096. Used to some extent for ties, mine timber and fuel when better wood is not available. Recently developed methods of seasoning and preservative treatment promise to make the lodgepole pine valuable for railway ties and mine timbers.

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Montana to southern Colorado, west to California and north to Alaska. This tree is found, as a rule, at higher elevations than the rock pine.

Genus PICEA, The True Spruces

Tall, conical, evergreen trees with tapering trunk and thin, scaly bark. Leaves needle-shaped, four-angled or flattened (ours four-angled) with sharp points. The leaves extend out from all sides of the twig in bottle-brush fashion; they are not in bundles as in pine but occur singly. Leaves jointed near the base, the lower part (sterigma) becoming woody and persistent after the fall of the leaf. Bare twigs thus appear roughened with short, truncate elevations. The stomata (pores) on the leaf surface may be seen with a good hand lens as white dots occurring in rows. Staminate flowers axillary; the carpellate terminal. Cones pendulous, the cone scales somewhat papery when mature. About 18 species all in the colder and temperate parts of the northern hemisphere. Various species are planted for ornament, or as windbreaks in exposed places.

Key to the Colorado Species of Picea

A. Leaves rigid, needle pointed, blue-green or silvery, branchlets smooth or at least not hairy. Cones about 7 cm. (2¾ in.) long. Frequent in cultivation. 1. **Picea parryana**

B. Leaves less rigid, abruptly pointed, having a somewhat skunk-like odor when bruised. The branchlets are generally described as pubescent but are smooth in specimens grown at high altitudes. Cones about 4 cm. (1½ in.) long. 2. **Picea engelmanni**

Picea parryana (Andree) Sarg. Blue Spruce, Colorado Blue Spruce

Rydberg, *Flora Colo.* 8; Coulter, *Manual* 431 (as *Picea pungens*); Sargent, *Manual Trees of N.A.* 44; Nelson, *Key to Rocky Mountain Flora* 6.

Leaves stout, rigid, four-angled, mostly 25 to 30 mm. long but on cone-bearing branches shorter and curved. Generally the leaves stand out from all sides of the branchlets but sometimes the under surface of horizontal branches has few leaves. Stomata (pores) in 4 to 7 rows on each of the four surfaces of the leaf. Color of leaves generally silvery or bluish-green when young, becoming duller with age. Individual specimens differ greatly in this regard. Cones about 7 cm. long; the cone scales rhomboid; corrugated; rounded or truncate at apex or sometimes with a few teeth.

A tree of medium size. Until the age of 30 or 40 years it forms a broad-based pyramid but later the lower branches die and the top may become ragged with branches rather far apart. Bark broken into small oblong, platelike scales; on old trunks thick and deeply grooved. Wood light, soft, weak; specific gravity 0.3740.

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Along the mountain streams of eastern Colorado, west to Utah and north to the Wind River Mountains of Wyoming, occurring singly or in small groves.

Much cultivated for ornament in this country and in Europe. There are numerous horticultural varieties propagated by grafting.

Picea engelmanni (Parry) Engelm. ENGELMANN SPRUCE

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 431; SARGENT, *Manual Trees of N.A.* 43; NELSON, *Key to Rocky Mountain Flora* 6.

Leaves ridged above and below so that they are rather four-sided; awl pointed; not so stiff as those of the blue spruce. Leaves at first covered with a bluish or silvery bloom which disappears later; slender, 25 to 30 mm. long on the ordinary branches but shorter on cone-bearing twigs; stomata in 3 to 5 rows on each of the four surfaces of the leaf. Cones 3 to 5 cm. long, the cone scales truncate or acute at tip, sometimes toothed.

A large conical tree of the higher foothills and mountains; near timber limit a straggling, prostrate shrub. Bark thin, broken into large, thin, loose scales. Wood light, soft, close grained, not strong; specific gravity 0.3449. Frequently used for lumber and for making charcoal. The bark has been employed for tanning leather. In some localities the Engelmann spruce has been largely cut for railway ties and to some extent for telegraph and telephone poles. It should be valuable for wood pulp.

In the Cascade, Selkirk and Rocky Mountain ranges of British Columbia and Alberta, south through the mountain states to New Mexico and Arizona, west to Oregon. It is by far the more abundant of our two species of *Picea* and is the common tree near timber line where it forms scrubby mats. In such situations it seldom bears cones.

The Engelmann spruce has been planted for ornament in the eastern United States and in Europe. Sometimes it is mistaken for the blue spruce. These two species of Picea are not easily distinguished; however, the size of the cones is usually a marked feature. In addition the number of rows of stomata on the leaves and the character of the bark should be noted. The leaves of the blue spruce are distinctly stiffer than those of the Engelmann spruce.

Genus **PSEUDOTSUGA,** DOUGLAS SPRUCE

Tall, conical, evergreen trees with thick, furrowed bark and strong wood resembling in quality that of the best hard pines. Branches horizontal or ascending with a somewhat more feathery appearance than the true spruces. Leaves linear, flat; with a short leaf-stalk; the face of the leaf grooved above and with a prominent midrib below. Stomata (pores) on the under surface. Flowers solitary, appearing early in spring; the staminate scattered along the branches, small, oblong-cylindrical; the carpellate reddish-purple, borne near the tips of upper branches, easily

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seen from a distance. Cones pendulous, cone scales persistent; bracts with prominent teeth giving the cone a fringed appearance. Three species of this genus are known; one in Japan, the other two in western North America. One of these latter occurs in Colorado.

Pseudotsuga mucronata (Raf.) Sudw. DOUGLAS SPRUCE, RED FIR

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 431 (as *Pseudotsuga douglasii*); SARGENT, *Manual Trees of N.A.* 53; NELSON, *Key to Rocky Mountain Flora* 6 (as *Pseudotsuga taxifolia*).

Leaves rather soft, not rigid, flat, channeled above and ridged below, 20 to 35 mm. long, dark yellow-green in color, narrowed to a short stalk; leaf scars not prominent. Cones pendulous, 5 to 10 cm. long, the bracts projecting beyond the scales. Each bract with two lateral teeth and the midrib projected as a rigid awn.

A tree of handsome conical form, especially when young; reaching the greatest size in the moist forests of Oregon and Washington. Bark on young trees smooth and thin; on older trees very thick and deeply furrowed; sometimes used in tanning. Wood hard; light red or yellow; specific gravity 0.5157; largely manufactured into lumber in the Pacific Northwest where it is generally known as "Oregon pine" or as "red fir." Used also for fuel, railway ties and piles.

British Columbia and Alberta southward through hills and mountains to northern Mexico and western Texas.

Frequently planted as an ornamental and shade tree in Europe and the eastern United States. Numerous varieties are distinguished in cultivation. It is propagated easily from seed and has been recommended for reforesting of cut-over timber lands in the central Northwest.

Genus ABIES, THE FIRS, BALSAMS

Tall, conical trees of colder regions and mountain districts; with linear, flat, sessile leaves, grooved above and having a notched apex. Although developed on all sides of the branches the leaves generally bend so as to form flat masses of foliage. On the upper cone-bearing branches the leaves are often curved and thick, with the upper surface convex instead of grooved. Branches developed on the main trunk in regular whorls; the branchlets show rather prominent circular scars where the leaves have fallen. Flowers produced in early spring, the staminate flowers numerous on the under sides of branches in the upper part of the tree; carpellate flowers chiefly on the upper sides of topmost branches. Cones erect, purplish-black or yellow, formed of closely imbricated scales; exuding a balsamic resin. The cone scales and bracts separate from the axis while this is still on the tree. Hence complete cones are never found under the trees but only scales and seeds.

About 25 species are known of which 9 occur in North America. The best known fir is *Abies balsamea* of the northeastern states and Canada. In this species

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distinct balsam blisters are found in the bark which contain the substance known as "Canada balsam." Only two species of Abies are known in Colorado.

KEY TO THE SPECIES OF ABIES IN COLORADO

A. Leaves of vigorous lower branches 2.5 to 4.5 cm. (1 to 1¾ in.) long; resin ducts of the leaves deeply imbedded, not close to the epidermis. Cones purple or nearly black. 1. **Abies lasiocarpa**

B. Leaves of vigorous lower branches 4.5 to 7.5 cm. (1¾ to 3 in.) long; resin ducts of the leaves close to the epidermis of the under surface; cones yellow, green or purple. Not found in northern Colorado. 2. **Abies concolor**

Abies lasiocarpa (Hook.) Nutt. ALPINE FIR

RYDBERG, *Flora Colo.* 9; COULTER, *Manual* 430 (as *Abies subalpina*); SARGENT, *Manual Trees of N.A.* 61.

Leaves flat, with prominent mid-vein, bluish-green; on vigorous lower branches 2.5 to 4.5 cm. long; on old parts and on cone-bearing twigs much shorter. Cone oblong-cylindrical, rounded, erect, purple or nearly black, 6 to 10 cm. long.

A medium sized tree with branches extending nearly to the base of the trunk; bark of young trees pale gray and smooth; on old trees broken with shallow fissures and roughened with thin orange-colored scales. Wood light, not strong, nor durable; of little value but sometimes used as firewood; specific gravity 0.3476.

High altitudes in the mountains throughout western North America.

This species is sometimes planted as an ornamental tree in the northern United States and in central Europe.

Abies concolor Lindl. WHITE FIR

RYDBERG, *Flora Colo.* 9; COULTER. *Manual* 430; *Sargent, Manual Trees of N. A.* 62.

Leaves mostly in two rows on the branchlets, more or less erect; on lower branches flat, straight, with rounded or pointed apex; length 4.5 to 7.5 cm.; on cone-bearing twigs shorter and generally curved. Cone ellipsoid-cylindrical, 7 to 13 cm. long, grayish-green, purple or yellow, with broad, closely imbricated scales. A large tree with narrow spirelike crown; the short, main branches bearing long, lateral branchlets; the whole forming frondlike masses of foliage. Bark of old trunks becoming very thick, deeply divided into broad, rounded ridges. Wood light, close grained, not strong nor durable; specific gravity 0.3638.

From the Pike's Peak region of the Rocky Mountains of Colorado west to Oregon and south to northern Mexico and Arizona reaching its greatest development in the Sierras of California. It is the only true fir in the arid regions of the great Basin.

This tree has been planted for ornament in some places and promises to be useful.

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VOLUME IV NUMBER 3

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

APRIL, 1907

Price, 50 Cents

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A THEOREM ON DIFFERENTIAL FUNCTIONS

By S. Epstein

In the theory of Algebraic Equations[1] it is shown that every rational symmetric function of the roots of an algebraic equation can be expressed rationally in terms of the coefficients. As a corollary of this Professor James Pierpont proves in Part I of his lectures on "Galois Theory of Algebraic Equations:"[2] Let R be a given domain of rationality and

$$f(x)=x^n+a_1x^{n-1}+a_2x^{n-2}+a_3x^{n-3}+\ldots.\ a_{n-1}x+a_n=0\ ,$$

an equation whose coefficients lie in R. Let its roots be $\xi_1, \xi_2, \ldots., \xi_n$. Then an integral rational symmetric function of $n-1$ of the roots, say $\xi_2, \xi_3, \ldots., \xi_n$, is an integral rational function of the remaining root ξ_1.

In the Theory of Linear Differential Equations it is shown[3] that a rational symmetric differential function of the integrals of a fundamental system $y_1 \ldots. y_n$ can be expressed rationally in terms of the coefficients and their derivatives. Let R be a given domain of rationality and

$$Py=\frac{d^ny}{dx^n}+p_1\frac{d^{n-1}y}{dx^{n-2}}+\ldots.+p_{n-1}\frac{dy}{dx}+p_ny=0,$$

a linear homogeneous differential equation with coefficients in R. Then as a corollary of Appell's Theorem we show (in analogy with the Theory of Algebraic Equations) that: *An integral rational symmetric differential function of* $(n-1)$ *solutions, say* $y_2 \ldots. y_n$, *is an integral rational function of* $\eta=\frac{y_1'}{y_1}$ and its derivatives, y_1 being the remaining solution.

The differential equation $Ly=\frac{dy}{dx}-\eta y=0$ has for a solution $y=y_1$.

[1] Burnside and Panton, Vol. I, Art. 78. (Fourth edition, 1899.)

[2] *Annals of Mathematics*, 2d Series, Vol. I, No. 4 (1899–1900), p. 116, Art. 3.

[3] Appell, *Annales de l'École Normale Supérieure*, Series II, Vol. X (1881), p. 400. See Schlesinger, *Handbuch der Theorie der linearen Differentialgleichungen*, Vol. I, Part 1, p. 41

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Let

$$Qy=\frac{dy^{n-1}}{dx^{n-1}}+q_1\frac{dy^{n-2}}{dx^{n-2}}+\ldots\ldots+q_{n-1}y=0$$

be a differential form such that, in the symbolic notation of Boole,

$$QLy=Py\,. \tag{1}$$

Evidently $y_2\ldots\ldots y_n$ is a fundamental system of the equation $Qy=0$.

The equation $Py=0$ being irreducible, the coefficients $q_1\ldots\ldots q_{n-1}$ are not in the domain R. Indeed, by performing the operations indicated in (1) and comparing coefficients there results:

$$p_1=q_1\eta\,,\qquad p_2=q_2-q_1\eta-(n-1)\eta'\,,$$

$$p_3=q_3-q_2\eta-(n-2)q_1\eta'-\frac{(n-1)(n-2)}{2!}\eta''\,,\quad\text{etc.,}$$

whence we obtain:

$$q_1=p_1+\eta\,,\qquad q_2=p_2+p_1\eta+\eta^2+(n-1)\eta''\,,$$

$$q_3=p_3+p_2\eta+p_1(\eta^2-\eta')+\eta^3+n\eta\eta'+\frac{(n-1)(n-2)}{2!}\eta''\,,\quad\text{etc.}$$

It is thus seen that the coefficients are rational in terms of $p_1\ldots\ldots p^n$, η, η', η'', $\ldots\ldots$.[1]

By Appell's Theorem, an integral rational symmetric differential function of the solutions $y_2\ldots\ldots y_n$ of $Qy=0$ is rational in the q's and their derivatives. Therefore it is rational in p_1, $\ldots\ldots$, p_n, η, and their derivatives.

[1] Indeed, if

$$Ty=\frac{d^m y}{dx^m}+t_1\frac{d^{m-1}y}{dx^{m-1}}+t_2\frac{d^{m-2}y}{dx^{m-2}}+\ldots\ldots t_m y=0$$

has m integrals in common with $Py=0$, then

$$Qy=\frac{dy^{n-m}}{dx^{n-m}}+q_1\frac{dy^{n-m-1}}{dx^{n-m-1}}+\ldots\ldots+q_{n-m}y=0$$

can be determined such that $QTy\equiv Py$. The coefficients t of T are in domain R. The coefficients q can be determined rationally in terms of the p's and t's. This computation was made by Miss Ruby L. Carstens who finds

$$q_1=p_1-t_1\,,\qquad q_2=p_2+p_1t_1-t_1'-mt_1'-t_2\,,$$

$$q_3=p_3-p_2t_1+p_1(t_1'-t_2-mt_1'+t_1')+2t_1t_2+mt_1t_1-t_3'+t_1t_1'(m-1)-t_3-(m-1)t_2'-\frac{m(m-1)}{2}t_1''\,,\quad\text{etc.}$$

The corresponding theorem where, instead of a domain of rationality, one takes a monotopic domain (i. e., a domain in which the coefficients are single valued) is given in SCHLESINGER's *Handbuch*, Vol. I, pp. 45, 46.

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ON AN ALGEBRA IN THREE UNITS

By S. Epsteen and Harry V. Welch

§ 1. Historical

Suppose that one is familiar with the arithmetic of positive integers only. In that case the equation $ax=b$ (a and b, positive integers) would, in general, not be solvable. In the domain of positive integers and fractions this equation would be solvable, whereas the equation $a+x=b$ would, in general, not be. Both of these equations can be solved if the domain is enlarged by the adjunction of negatives. In order to solve the equation $x^n=a$ (n, a, positive integers) the latter domain must be further extended by the introduction of the irrational number. Let us designate the final domain thus obtained by $R(1)$. The developments in algebra prior to the nineteenth century are characterized by the fact that *they were studies of the domain* $R(1)$. The equation $x^2=-1$ is not solvable in this domain and its root, $i=\sqrt{-1}$, was said to be imaginary, i.e., exterior to the domain $R(1)$. Through the publications of Argand and Gauss, at the close of the eighteenth century and beginning of nineteenth, the properties of this new unit became known to the mathematical world and for the next half-century mathematicians studied the algebra of the units $1, i$, that is, the so-called complex algebra. Therefore, we may say: *during the first half of the nineteenth century the progress in algebra consisted in complete discussion of the domain* $R(1, i)$.[1]

The fundamental theorem of these investigations is due to Gauss: the equation $a_0x^n+a_1x^{n-1}+\ldots.a_n=0$ (n positive integer, $a_1, a_2, \ldots. a_n$ belonging to $R(1, i)$ has at least one root belonging to $R(1, i)$.[2]

[1] Historically, the real number system including positive integers and fractions was known to the Egyptians, over 1700 B. C. The irrational numbers were discovered by the Greeks as a corollary of the theorem of Pythagoras. To the Hindoos belongs the credit of inventing the zero, about the fifth century A. D., in consequence of which negative numbers were discovered. In 1806 Argand made public a method of representing $i=\sqrt{-1}$ geometrically, thus completing the number system of algebra.

[2] This is the so-called fundamental theorem of algebra.

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In order not to interrupt the argument which will follow, we point out here that the unit of the domain $R(1)$ has the multiplication table,

	e_1
e_1	e_1

e_1 having the ordinary properties of unity. The units of the domain $R(1, i)$ have the multiplication table

	e_1	e_2
e_1	e_1	e_2
e_2	e_2	$-e_1$

where e_1 has the properties of unity, e_2 the properties of $i = \sqrt{-1}$.

The general number of the latter algebra is $a_1e_1 + a_2e_2$, where a_1 and a_2 are reals.

Since all the numbers of the domain $R(1)$ are represented graphically by the totality of points on a straight line and all the numbers $a_1 + ia_2$ of the domain $R(1, i)$ are represented by the totality of points of a plane, one might infer that the totality of points in space is the geometric representation of some algebra in three units. Proceeding on this thought Hamilton attempted to set up a three-unit system e_1, e_2, e_3 which would have this property. In the introduction to his *Quaternions* he proved that no such system exists when the coefficients a_1, a_2, a_3, of the general number $A = a_1e_1 + a_2e_2 + a_3e_3$ belong to the domain of reals $R(1)$. His proof consists in showing that any algebra in three units, the coefficients belonging to $R(1)$, contains numbers $x = x_1e_1 + x_2e_2 + x_3e_3$ and $y = y_1e_1 + y_2e_2 + y_3e_3$, both different from zero, for which the product $xy = 0$.

As Benjamin Peirce points out in his memoir on "Linear Associative Algebra,"[1] Hamilton's investigation should be made in the field of complex numbers instead of in the field of real numbers. In other words, the coefficients a_1, a_2, a_3, of the number $A = a_1e_1 + a_2e_2 + a_3e_3$ should be considered as belonging to the domain $R(1, i)$ rather than to the domain $R(1)$.

The problem of the present paper consists in carrying out Peirce's thought for one interesting algebra in three units e_1, e_2, e_3. The algebra

[1] *American Journal of Mathematics*, Vol. IV (1881), p. 9, footnote.

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in question is assumed to have the property that when e_3 is deleted the remaining units e_1, e_2 will form the ordinary complex algebra. That is to say, it has, in part, the multiplication table:

	e_1	e_2
e_1	e_1	e_2
e_2	e_2	$-e_1$

It is assumed that e_1 is the *unity* or *modulus* for our algebra, i. e., $e_1e_3 = e_3e_1 = e_3$. The multiplication table may, therefore, be written:

(1)

	e_1	e_2	e_3
e_1	e_1	e_2	e_3
e_2	e_2	$-e_1$	$p_{231}e_1+p_{232}e_2+p_{233}e_3$
e_3	e_3	$p_{321}e_1+p_{322}e_2+p_{323}e_3$	$p_{331}e_1+p_{332}e_2+p_{333}e_3$.

We assume, moreover, that this algebra has in common with ordinary algebra the property that all its numbers are commutative. In particular, then, $e_2e_3 = e_3e_2$ and therefore:

(2)
$$p_{321} = p_{231}$$
$$p_{232} = p_{322}$$
$$p_{233} = p_{323} .$$

It will be shown *that the desired algebra has the multiplication table:*

	e_1	e_2	e_3
e_1	e_1	e_2	e_3
e_2	e_2	$-e_1$	$ae_1+iae_2+ie_3$
e_3	e_3	$ae_1+iae_2+ie_3$	$be_1+(ac-ia^2-ib)e_2+ce_3$,

a, b, c, being any quantities in the domain $R(1, i)$; *and also that this algebra is reducible.*

§ 2. The Multiplication Table of the Algebra

I. Besides modifying the multiplication table (1) in accordance with the commutative law [i. e., introducing the equalities (2)] account must be taken of the associative law

$$e_ie_j \cdot e_k = e_i \cdot e_je_k .$$

The associative condition,

(3)
$$e_2e_2 \cdot e_3 = e_2 \cdot e_2e_3$$

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gives the identity,

$$(4) \qquad -e_3 = p_{231}e_2 - p_{232}e_1 + p_{233}(p_{231}e_1 + p_{232}e_2 + p_{233}e_3) .$$

Equating coefficients of e_1, e_2, e_3, there result:

$$(5) \qquad -p_{232} + p_{233}p_{231} = 0 ,$$

$$(6) \qquad p_{231} + p_{233}p_{232} = 0 ,$$

$$(7) \qquad p_{233}p_{233} = -1 .$$

From (7),

$$(8) \qquad p_{233} = \sqrt{-1} = i ,$$

and it is easily seen that (5) and (6) are both equivalent to the single relation

$$(9) \qquad p_{232} = ip_{231} .$$

The associative condition,

$$(10) \qquad e_2e_3 \cdot e_3 = e_2 \cdot e_3e_3 ,$$

and the relations of commutativity, give the identity

$$p_{231}e_3 + ip_{231}(p_{231}e_1 + ip_{231}e_2 + ie_3) + i(p_{331}e_1 + p_{332}e_2 + p_{333}e_3) = p_{331}e_2 - p_{332}e_1 + p_{333}(p_{231}e_1 + ip_{231}e_2 + ie_3) .$$

Equating coefficients of e_1, e_2, e_3,

$$(11) \qquad ip_{231}^2 + ip_{331} = -p_{332} + p_{333}p_{231} ,$$

$$(12) \qquad -p_{231}^2 + ip_{332} = p_{331} + ip_{333}p_{231} ,$$

each of which gives,

$$(13) \qquad p_{332} = p_{333}p_{231} - p_{231}^2 - ip_{331} .$$

Let:

$$(14) \qquad \begin{aligned} p_{231} &= a , \\ p_{331} &= b , \\ p_{333} &= c , \end{aligned}$$

a, b, c, being any numbers in the domain $R(1, i)$.

In view of (2), (8), (9), (13), (14), the multiplication table of the algebra takes the form:

(15)

	e_1	e_2	e_3
e_1	e_1	e_2	e_3
e_2	e_2	$-e_1$	$ae_1 + iae_2 + ie_3$
e_3	e_3	$ae_1 + iae_2 + ie_3$	$be_1 + (ac - ia^2 - ib)e_2 + ce_3$.

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II. As stated at the end of § 1 this algebra is reducible.[1] Making the following transformations upon the units:

$$e_1' = \frac{e_1 + ie_2}{2}$$

$$e_2' = \frac{e_1 - ie_2}{2} \tag{16}$$

$$e_3' = x_1 e_1 + x_2 e_2 + x_3 e_3$$

$$\left(\text{where, } x_3 = \frac{x_2 + ix_1}{a}\right),$$

the multiplication table takes the form:

	e_1'	e_2'	e_3'
e_1'	e_1'	0	0
e_2'	0	e_2'	e_3'
e_3'	0	e_3'	$ke_2' + le_3'$,

in which

$$k = \frac{2}{a}[b(x_2 + ix_1)^2 - cx_1(x_2 + ix_1) + a(x_2^2 - x_1^2)],$$

$$l = 2i(x_2 - ix_1) + \frac{c}{a}(x_2 + ix_1).$$

[1] For the definition of reducibility see EPSTEEN, *Transactions of American Mathematical Society*, Vol. V, pp. 106–9.

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THE APPEAL OF ALEXIUS FOR AID IN 1095

By Edward Tuthill

Many historians affirm that the immediate occasion, if not the cause, of the First Crusade was an appeal by the Eastern Emperor, Alexius I, to Pope Urban II for aid against the Turks, who were said to be threatening the city of Constantinople with destruction. The most convenient and comprehensive version of this story appears in Gibbon's great work; and an excerpt is given here because it reflects present tendencies in our textbooks and reference works. At the Council of Placentia, which was held in March, 1095—

> The ambassadors of the Greek emperor, Alexius Comnenus, were introduced to plead the distress of their sovereign, and the danger of Constantinople, which was divided only by a narrow sea from the victorious Turks, the common enemy of the Christian name. In their suppliant address they flattered the pride of the Latin princes; and, appealing at once to their policy and religion, exhorted them to repel the barbarians on the confines of Asia rather than to expect them in the heart of Europe. At the sad tale of the misery and perils of their Eastern brethren, the assembly burst into tears; the most eager champions declared their readiness to march; and the Greek ambassadors were dismissed with the assurance of a speedy and powerful succor. The relief of Constantinople was included in the larger and most distant project of the deliverance of Jerusalem; but the prudent Urban adjourned the final decision to a second synod, which he proposed to celebrate in some city of France . . . .[1] [i.e., Clermont].

The purpose of this study is to show that the evidence for this famous appeal is very slight; that many chroniclers in Italy and France who heard about the council omit this incident; that the Crusaders, also, were apparently unaware of it; and that the eastern empire, according to our best authorities, had no occasion to seek aid in 1095 because the Turks were then engaged in fierce civil wars. We shall take up these points in order.

Little Evidence to Support This Appeal

Only one chronicler strictly contemporary[2] with the event described gives definite information about this appeal. This is Bernold of Con-

[1] Gibbon, *Decline and Fall*, chap. lviii.

[2] Otto of Freising, *Chronicon*, VII, c. 2; Gislebert de Mons, *Chron. Hanoniae* (ed. Arndt), p. 56; Benedictus Accoltus, circa 1470; and Guillaume Aubert, of the sixteenth century, add nothing to the earlier narratives, and are not contemporary.

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stance, whom historians generally accept as entirely trustworthy. He was, however, a violent partisan of Urban and Gregory in the Investiture Strife.[1] He would therefore be inclined to magnify the prestige of Urban II as against Guibert the anti-Pope whenever an opportunity presented itself. But it is a significant fact that Bernold nowhere indicates that he was an eyewitness of the presentation of the Greek envoys, nor even that he was present at the council itself.[2] These considerations alone suggest the exercise of much caution before accepting the full account so freely rendered by Gibbon from Bernold's chronicle.

Moreover, our caution gives rise to serious doubts when we examine the testimony of another writer who, unlike Bernold, is known to have been present at the council. This was Donizo, the friend and biographer of Countess Matilda of Tuscany, who accompanied Urban to the council. Donizo was attached to the retinue of the Countess and thus enjoyed exceptional opportunities as a news-gatherer in diplomatic circles. Several events, such as Guibert's heresies, the conduct of Praxedis, and other public business, engaged his attention and are recorded in his *Life of Matilda*[3] but the appeal by the Emperor, which was in all respects the most impressive event that could possibly occur on this occasion, he utterly ignores. The eastern empire is nowhere mentioned as a subject of discussion, much less the taking of oaths by Crusaders to support that empire. Donizo's brief but valuable statements possess as much virtue as Bernold's and should be used for the same purpose. He could have no discernible motive in suppressing such an event.

What We Learn from Chroniclers in Italy and France

In the same account Bernold maintains that the council consisted of more than thirty-four thousand persons, including bishops from Italy, France, Burgundy, Swabia and Bavaria. After making a liberal allowance for exaggeration—because only large figures could impress the

[1] See Potthast, *Wegweiser durch Mittelalter* . . . . for list of his controversial writings.

[2] When he says, "Missas quoque nonnunquam extra ecclesiam satis probabiliter, necessitate quidem cogente, celebramus," he is merely justifying the celebration of mass in the open air, sometimes permitted by the Church.

[3] Donizo, *Vita Mathildis*, in Migne, *Patrol. Lat.*, cxlviii, 1015. The biography as a whole is poor, as Wattenbach has justly observed (*Quellenkunde*, 5. Auf., II, 215). On the other hand, Donizo remembered this council distinctly—"quam saepe recordor," he says.

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medieval man—there should remain a sufficient number of eyewitnesses to herald the acts of the council throughout Western Europe. For, when all these churchmen returned home, they were compelled by the conditions of medieval travel to tarry for food and rest at numerous monasteries—the hotels of the Middle Ages; ecclesiastics from Salzburg, Passau, Constance and other distant cities would be guests in many places where courtesy would require a full answer to the inquiring abbot or chronicler who wished to learn the acts of the council. Indeed, the intimate bond existing between the papacy and the monks created an intense interest in every incident affecting the progress of the true Pope as against the anti-Pope. Had the eastern Emperor "humbly implored the Pope and all the Faithful," as Bernold alone asserts, the good news could not have been concealed from so many chroniclers who heard something about this council but who record nothing about an appeal from the East.[1]

From Placentia Urban and his retinue proceeded by easy stages into France, dedicating churches by the way and meeting various bishops.[2] At Clermont he delivered the famous exhortation which induced so many thousands to take the cross. This oration was reported by a group of writers[3] who thus had ample opportunity to learn all the important acts of the previous council. With such facilities at hand, all but one of these writers omitted Placentia, and the one exception—Baldric of Dol—remembered that it was a "general synod." This result is the more striking because each writer alludes briefly to the origin of the Crusade. Urban himself seems to have made no allusion to Placentia, and it is plain that these contemporaries, like their brethren in Italy, did not think of such an appeal as Bernold alone records. It is equally plain, however, that complaints of the eastern Christians were abundant throughout this period. The Pope reminded his hearers of the frequent tales of misery brought from Jerusalem, Constantinople and the East;[4]

[1] Besides those cited above, see PANDULF OF PISA in *Muratori*, III, p. 352; ORDERICUS VITALIS, lib. IX, c. i: "Urbanus papa Placentiae concilium tenuit, et de pace aliisque utilitatibus sanctae Ecclesiae diligenter tractavit." GAUFREDUS MALATERRA has no record of it.

[2] See Urban's itinerary in JAFFÉ'S *Regesta* (1885).

[3] ROBERT THE MONK, BALDRIC, and probably FULCHER and GUIBERT; see *American Historical Review*, Vol. XI, pp. 232, 233.

[4] *Recueil des Historiens des Croisades*, III, 323; 727; also IV, 12–13.

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Baldric says refugees were often seen;[1] Ekkehard of Aurach saw in the Holy Land in 1101 copies of appeals by the eastern churches to western Christians.[2] To explain Bernold's error, then, we may assume that he heard something about a delegation from the East seeking aid. As it came through, or even from, Constantinople, he hastily concluded that it was an imperial embassy.

Two chroniclers sometimes cited as confirming Bernold are the Italian called Lupus Protospatarius and the anonymous author of the annals of Jumièges (*Annales Gemmaticenses*). The former records a brilliant display of meteors in April, 1095 and adds: "And afterwards the people of Gaul, yea of all Italy, began to march to the Sepulchre of the Lord with their arms and with a cross on the right shoulder."[3] It requires a number of assumptions to show that this notice has any connection with an appeal at Placentia. The people of Gaul did not start until after the Council of Clermont in November, and probably the author—whose identity and name are unknown—meant nothing more than to associate the meteors with the subsequent crusade thus foreshadowed.[4]

The second notice mentioned above runs as follows: "In the same year [1095] Pope Urban who had held a council in Italy to encourage men to go to Jerusalem, held a second council at Clermont and commanded Christians to go to Jerusalem with crosses affixed to their garments."[5] This would be a very significant notice if it were contemporary; but it seems to be of late origin. Of the two manuscripts extant, that of Paris belongs to the fifteenth and that of the Vatican to the eighteenth century. A third manuscript, no longer extant, is said to have been incorporated in Sigebert's *Chronicon* but the latter does not allude to

[1] *Ibid.*, IV, 12: "Videbamus aliquando cives ipsius Jerusalem inter nos, mendicos et exulos; videbamus indigenos Antiochiae." Observe the imperfect tenses.

[2] *Hierosolymita* (ed. *Hagenmeyer*), V, c. 2: "Per legationes tamen frequentissimas et epistolas etiam a nobis visas universalem ecclesiam ecclesiae Hierosolymitanae in presidium lugubriter inclamantes."

[3] *Chronicon*, anno 1095: "De mense Aprilis in nocte quinta feria subito visi sunt igniculi cadere de caelo quasi stellae per totam Apuliam . . . . Et ex tunc (exterius) coeperunt Galliae populi pergere, immo totius Italiae, ad sepulchrum Domini cum armis ferentes in humero dextro crucis vexillum."

[4] Even in our own times the comet of 1861 was supposed to portend the Civil War.

[5] *M. G. SS.*, XXVI, p. 508: "Eodem anno Urbanus papa qui prius in Italia concilium tenuerat pro exhortatione Yerosolymitani itineris iterum apud Clarum Montem concilium tenuit et constituit, ut Christiani fixis crucibus in vestibus Ierusalem pergerent." Cf. also p. 489 and references. Cf. *Chron. Casin.*, in *M. G. SS.* VII. 765.

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any appeal for aid.[1] The next entry in the *Annales* after 1095 is a notice of Urban's death in 1099. Moreover, the authorship of this portion of the *Annales* is unknown and no allusions are made to Placentia or to the Eastern Empire.

The Crusaders and Their Historians

Yet another indication of the general ignorance of such an appeal as Bernold describes appears in the letters and chronicles written by the Crusaders in the East. Their indignation against Alexius waxed hot when they discerned that he was using them for his own purposes. They complained about many things. They even declared in a letter to Urban that Alexius had promised much and granted little, thus violating the agreement at Constantinople.[2] In all these complaints, however, there is no phrase accusing the Emperor of lack of hospitality to invited guests. The Crusaders did not suggest the claims of hospitality at Constantinople, nor do they recall any such promises when their sufferings ought to have provoked these charges as the very first accusation. Though a hundred thousand Crusaders[3] were directly concerned in this matter, they have left no record of it either in their extant letters or in the influence which they must undoubtedly have exerted, after their return, upon the writers of chronicles in the West.

Among the historians of this crusade two contemporaries deserve especial mention. One of these was Guibert of Nogent, a French abbot, who probably witnessed the Council of Clermont. Here he may have talked with members of Urban's retinue who had come from Italy. Some years later, after the capture of Jerusalem, Guibert decided to write a history of the expedition.[4] He gave it a famous title—*Gesta Dei per Francos*. While it is a valuable account, its author confesses his

[1] *M. G. SS.*, XXVI, p. 489, MS. S. Mariae de Voto. Sigebert's *Chronicon* mentions only the massacre of the Jews and the storming of Jerusalem in his account of the crusade.

[2] Consult numerous letters in Hagenmeyer, *Kreuzzugsbriefe*, especially that of the Leaders to Urban from Antioch, 1098; " . . . . tu vero nos filios, pater piissime, debes separare ab iniusto imperatore qui multa bona promisit sed minime fecit." Hence they ask to be absolved from their contract with Alexius. See Hagenmeyer, *ibid.*, 161 and 357.

[3] Some estimates exceed 300,000: Sybel, *Gesch. des ersten Kreuz.*, 284, note.

[4] *Recueil des Hist. des Crois.*, IV, 120: "Nec diffiteor me post Iherosolym captionem, ex quo illi qui interfuerant expeditioni redire coeperunt, ad scribendum ea animum appulisse."

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faults with respect to rhetorical display.[1] This besetting sin often obscures the truth. The narrative shifts quickly from prose to verse, and the involved sentence is not always precise. An excellent illustration of this tendency appears in Guibert's version of the appeals. He says Urban was moved by the gifts and entreaties of Alexius to come into France, but much more by the general dangers that threatened Christendom as a result of Saracen attacks from Spain.[2] He does not specify any appeal in particular, nor does he allude to any council in Italy. This in itself tends to show that he did not consider Placentia worthy of record in this connection; and the omission is the more striking because he devoted two books to the preliminaries of the crusade. He had previously recorded the letter of Alexius to his patron, Robert of Flanders, about 1088, and therefore knew that Alexius had sought aid. His allusion to gifts doubtless goes back to the appeals of 1082 and 1085, recorded by Anna Comnena,[3] the daughter of Alexius, an eyewitness of the First Crusade. At any rate, Guibert significantly employs the plural form—*precibus*—thus uniting all the earlier appeals. And, far from ascribing supreme importance to any one of them, he regards them all as inferior to such other factors as Urban's French training and Saracen raids from Spain. In this he is undoubtedly correct and modern historians ought to follow him rather than Bernold as a guide for the First Crusade.

The second historian who deserves examination is Ekkehard of Aurach, a German monk, whose *Chronicon Universale* contains much information on this period. We are fortunate in having both the earlier and later drafts of this work. In the earlier draft the entries for the years 1095, 1096, and 1097 show no knowledge of appeals for aid by Alexius and no prejudice against him.[4] But in 1101 Ekkehard went

[1] *Recueil*, IV, 118: Decet enim licetque prorsus operosa historiam verborum elegantia coronari. *Cf.* also THUROT in *Revue Historique*, II, 107.

[2] *Recueil*, IV, 135: "Is itaque vir eximius quum ab Alexi Graecorum principe magnis honoraretur exeniis, et precibus quidem, sed multo propensius generali Christianitatis periculo pulsaretur, quae quotidianis gentilibus minuebatur incursibus (Sarracenorum namque irruptionibus Hispanias audiebat saepissime conturbari) pro hoc ipso, suae gentis sollicitaturus homines, commeatum facere destinavit in Franciam."

[3] *Alexiad* (ed. *Reifferscheid*, 1884) lib. III, c. 10; lib. V, c. 3, 5; for the appeal of 1088 see lib. VI., c. 6, 7, 11. For an appeal about 1091 see lib. VIII, c. 5, and CHALANDON, *Essai sur le Règne d'Alexis Ier*, p. 129. These are all confirmed by one or more Latin writers.

[4] See text and readings in MIGNE'S *Patrologia*.

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to Jerusalem as a pilgrim. While in the East he saw and heard so many new things that he decided to rewrite the story of the crusade. Returning in 1102 by way of Rome, he carried out his resolution, and called the new work the *Hierosolymita*. In it he expresses the prejudices which he contracted while associating with the Crusaders.[1] In several places he applies harsh epithets to Alexius[2] although he had no personal grievances against him. Fortunately for our purpose, Ekkehard twice mentions appeals from the East. In chapter v, section 2 he says he saw circular letters asking for western help, as given above.[3] But in section 3 of the same chapter he says Alexius sent many letters to Urban, asking the entire Occident to hasten to his relief and promising the necessary supplies for all both on sea and land.[4] This extravagant rumor does not appear in any other writer, and Ekkehard carefully refrains from saying that he saw any of these letters in any form. He does not furnish any particulars about such letters, and we know that he could not have seen them at Rome.[5] Neither could he have learned of them from Urban, who died three years before Ekkehard visited Italy. He does not mention Placentia at all. What he gives he probably accepted because it harmonized with the common estimate of the character of Alexius. Long before 1102 it was perfectly plain that the Emperor had cleverly used the Crusaders for his own advantage; Raymond says the people hated him bitterly.[6] Thus Ekkehard merely joined in the popular refrain.

The Condition of the Empire in 1095

Finally, we may examine the best authorities as to the condition of the Empire. If, as Bernold says, the strait alone saved the capital, then Alexius may well have sought aid. Unfortunately, the words

[1] Details in *Hagenmeyer's* edition (Tübingen, 1877).

[2] Notably in chapters xiii and xxiv.

[3] See note 2, p. 138.

[4] "Predictus etiam Alexius . . . . non paucas epistolas Urbano papae direxit, quibus in defensionem orientalium ecclesiarum se non sufficere deploravit, obtestans totum, si fieri posset, Occidentem sibi in adiutorium advocari, promittens per se cuncta necessaria proeliaturis terra marique ministrari."

[5] The anti-Pope destroyed Urban's correspondence in August, 1098. *Archives de l'Orient latin*, I, p. 107.

[6] *Recueil* III: "Populus semper ei maledicat et proclamet eum proditorem." They also believed he abandoned the company of Peter the Hermit near Nicea.

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which Bernold attributes to the embassy of 1095 recur in almost identical phraseology in Gregory's letter[1] of March 1, 1074, addressed *To All Christians*. But if we waive this objection as to form, we must insist that the contents also are at least misleading. Granting some exaggeration on the part of the envoys, we must nevertheless deny the circumstantial evidence supporting the alleged appeal. No crisis existed in or about 1095, to justify any appeal. When Alexius sought aid in 1082, 1084 and 1088 there were special reasons for his actions. A call for mercenaries about 1091 was merely incidental to the use of such troops.[2] Certain writers assert without adequate proof[3] that Alexius was planning the recovery of the provinces which were lost in 1071. If this be true, they are really denying the necessity, and consequently the probability, of an appeal in 1095.

The latest work devoted to the reign of Alexius declares plainly that in 1095 the empire was enjoying greater peace and tranquillity than it had known in fifteen years.[4] There are two reasons for this condition: the increasing control which the new ruler was exercising, and the dissensions of his enemy, the Turk. In 1081 Alexius was a usurper; by 1095 he had put down his rivals and ruled without dispute. Secondly, the Sultan Malek-Shah died in 1092 and the rival factions among the Turks quarreled savagely over his dominions.[5] So fierce were their wars that the Crusaders' success was almost inevitable, and the alliance with Egypt a logical result. So little was the great city in danger that the motley hosts of Peter the Hermit advanced perhaps a hundred miles beyond the strait before they met their fate.

[1] JAFFE, *Regesta*, 4826. and MIGNE, *P. L.*, CLXVIII. 329: " . . . . cognovimus gentem paganorum contra Christianum fortiter invaluisse imperium, et miseranda crudelitate jam fere usque ad muros Constantinopolitanae civitatis omnia devastasse et tyrannica violentia occupasse, et multa millia Christianorum quasi pecudes occidisse" (1074).

Bernold merely substitutes the churches for the empire—"ecclesiam, quam pagani jam pene in illis partibus deleverant, qui partes illas usque ad muros Constantinopolitanae civitatis obtinuerant, ..." (1095).

[2] *Essays on the Crusades* (1903) p. 92, the words of M. Diehl. Cf. also FREEMAN, *Norman Conquest* (1873), IV, 426–428.

[3] For example, KUGLER in *Hist. Zeitschrift*, 1866, p. 304, note 16; a critical contention in his thesis, but no proof.

[4] CHALANDON, *Essai* . . . . (1900), pp. 156, 158.

[5] RÖHRICHT has an admirable résumé, with citations to the sources, in his *Geschichte des ersten Kreuz.*, 226–234.

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Conclusion

It is therefore strangely significant that no eyewitness of the council, no contemporary chronicler, no Crusader who passed near Placentia on his way to the Orient, no Crusader who wrote home about the expedition, no contemporary Latin historian, no Greek contemporary, no official document either Latin or Greek, and no events within the empire itself furnish any definite corroboration of Bernold's story concerning an official appeal involving the two greatest potentates of Europe, delivered before an immense assembly, and distinctly regarded by modern historians as the immediate occasion of the First Crusade. Three eminent historians must be exempted from this charge. Friedrich von Raumer felt misgivings as to the alleged appeal because Anna Comnena did not mention it. He concealed his opinion in a footnote after giving the traditional tale.[1] Somewhat more boldly Count Riant challenged it, but confined his criticism to the omissions in Italian writers.[2] Very recently Röhricht confessed his inability to reconcile the program of Placentia with that of Clermont because Jerusalem does not appear in the former. He regrets that his sources do not afford an adequate explanation.[3] Thus have three eminent scholars presented their objections, each from a different standpoint. The present study arises out of a consideration of these and other suggestions, seeking indeed not a complete proof of the impossibility of an appeal in 1095, but a demonstration of the improbability of Bernold's story, in the light of all the evidence extant. Great events do not always have a dramatic inauguration: although our Civil War began with the firing on Fort Sumter, the Russo-Japanese war began when Japan was ready to spring and without previous announcement of hostilities. The Council of Clermont furnishes a sufficiently dramatic inauguration of the Crusade. Its basis is a long series of appeals—military, ecclesiastical and personal—and not the single incident recorded by a solitary writer.

[1] *Gesch. der Hohenstaufen und ihrer Zeit* (1857), p. 28 note 3.

[2] *Epistola Spuria* (1879), xxii, *et passim*.

[3] *Geschichte des ersten Kreuz.*, pp. 19, 20: " . . . . ihr Ziel war aber nicht mehr, wie noch in Placenza, Constantinopel, sondern Jerusalem, ihre Gestalt nicht mehr die blosse Defensiv, sondern die Offensiv. Wodurch diese Verschiebung und Veränderung eigentlich veranlasst wurde, sagen die Quellen nicht. Vielleicht . . . . " u. s. w. The easiest escape from this dilemma is to ignore Bernold.

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SCIENTIFIC EXPEDITION TO NORTHEASTERN COLORADO

INTRODUCTION

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I. GENERAL ACCOUNT WITH OBSERVATIONS ON TOPOGRAPHY AND METEOROLOGY

BY GIDEON S. DODDS

During the summer of 1906 the University of Colorado sent out a scientific expedition to the northeastern part of the state, under the direction of Junius Henderson, curator of the museum. The expedition started from Boulder on June 7 and spent thirty days in the field. The party, consisting of four persons connected with the departments of Biology and Geology, traveled by wagon and visited parts of Boulder, Larimer and Weld Counties. The total distance covered was over 350 miles.

The purpose of the expedition was to cover considerable ground and to do work of a preliminary nature rather than to make exhaustive collections. In the field each man had his part of the work to do. In this way it was possible to collect a considerable variety of materials. Probably the most valuable part of the collections made are the fossil specimens from various localities. The plant collections are also important. During the trip a large number of small lakes were visited and a considerable collection of mollusks made. A small collection of bird

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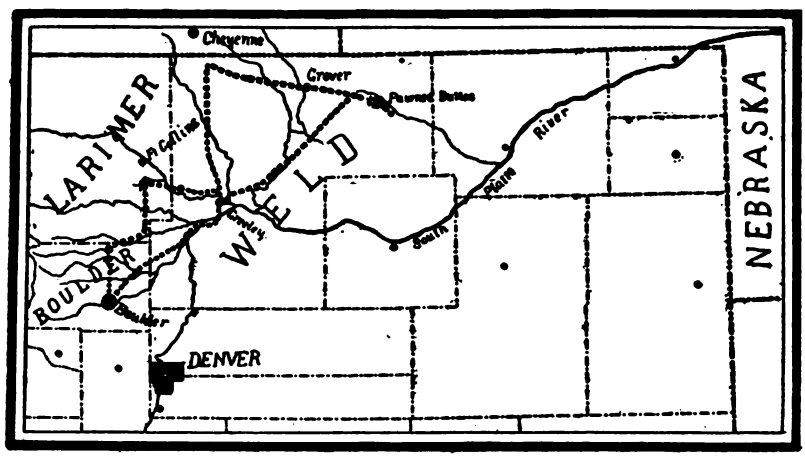
and mammal skins was also made. In addition to these, miscellaneous specimens were obtained including insects, reptiles etc. Besides the actual collecting an important part of the work was the preparation of notes on such points as topography, stratigraphy, distribution of birds, etc. Also a considerable number of photographs were taken showing the character of the country and other points of interest.



MAP SHOWING ROUTE OF THE EXPEDITION

On the above map the route of the expedition is indicated by the heavy broken line. Near Lyons about 15 miles north of Boulder plant collections were made and on the Little Thompson Creek a few miles farther on a small collection of fossils. On Fossil Creek, near Trilby siding, a few miles south of Fort Collins, the expedition made a halt of five days and collected considerable fossil and plant material, as well as some birds and mammals. From the exposures on the south side of the Cache la Poudre River near Windsor, an interesting collection of fossils was made. Near the Davis ranch, a few miles east of Grover, a few vertebrate remains were collected from the Tertiary exposures. The plant collections described in another part of this paper were made in this locality. Some valuable fossil material was obtained along Crow Creek, between this place and Greeley and also near the mouths of the Thompson and St. Vrain Creeks southwest of Greeley.

An important part of the work of the expedition was done in the northern part of Weld County, on the borders of the high plains, so a brief account of the topography and climatic conditions of this region may be of interest. Extending in an east and west direction, near the

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Wyoming and Nebraska line, is a series of bluffs facing southward. These are a very striking feature of the landscape,[1] rising in places as perpendicular cliffs to a height of perhaps 200 feet. Isolated remnants, parts of the cliffs separated by long continued erosion, remain standing in places as imposing towers rising high above the plains. Of these, Pawnee Buttes are striking examples. In these cliffs are exposed the clays and sand-stones of Tertiary age which are so rich in vertebrate remains. From the base of these cliffs the rolling plains slope gently away southward to the Platte River. From the top of the cliffs, the high plains[2] extend away to the northward.

The Tertiary formations bordering the high plains were visited first at Chalk Bluffs,[3] near Cheyenne. Though fossil remains are very plenty in these formations at other places, the expedition was unable to find any in this locality. Around the Davis ranch, a few miles east of Grover, these formations are very rich in vertebrate remains. Here an expedition from the American Museum of Natural History about seven years ago camped for a considerable time and collected much valuable material. Our expedition spent only six days in this region, making collections noted in the following article. A knowledge of the country and of conditions here, and about Pawnee Buttes a few miles farther east, was gained. This knowledge will be of value in future work.

The climate of the region is an arid one. The amount of rainfall at Pawnee Buttes can only be approximated by comparing records from the nearest stations which are about 50 miles away. At Cheyenne, Wyoming, the mean annual rainfall is 12.20 inches. At Greeley it is 11.16 inches. In the Pawnee Buttes region it is probably somewhat greater, possibly 13 inches. This is less than at most places on the eastern plains of the state. The streams in this region are intermittent, most of them carrying only storm water. In most localities wells of moderate depth give a fair supply of good water. The meager rainfall supports a growth of grass sufficient to pasture a considerable number of cattle and sheep. Besides grasses the plants are chiefly early-flowering perennial herbs with some late-blooming composites such as species of Artemisia. This growth of vegetation would not be possible with so

[1] See Fig. 1, Plate I. [2] See Fig. 2, Plate I. [3] See Fig. 1, Plate II

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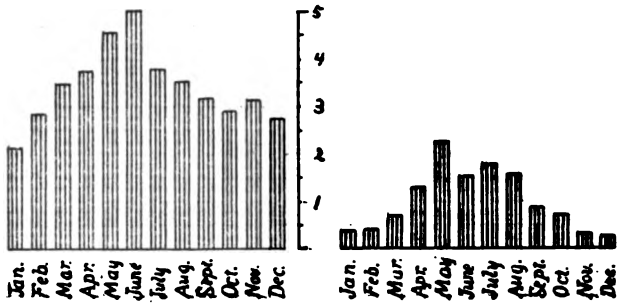
little precipitation but for the fact that by far the greater part of the year's rain falls during the spring and early summer. Were it distributed more evenly throughout the year, there would not be enough during the growing season to support even this small amount of vegetation. This unequal distribution of rainfall is characteristic of arid climates. In more humid climates there is a more general distribution throughout the year. A comparison of these two conditions is shown in the accompanying diagrams. Cheyenne with a rainfall of 12.20 inches is taken as a type of the arid region and St. Louis with 40 inches is used as a type of the more humid. The rainfall for the different months is shown in inches. The temperature of this region presents no local features of



MONTHLY DISTRIBUTION OF RAINFALL AT ST. LOUIS, MO., AND CHEYENNE, WYO.
(See Explanation in Text)

interest. The winters are cold, the summers hot. The extremes between day and night are considerable, as is common in arid climates.

The work of this expedition is but the beginning of what the University hopes in time to be able to do. Here in Colorado the naturalist has before him a very exceptional field. In a large part of the state little scientific work has been done. The wide diversity of climatic conditions occurring within the state, from mountain to plain, support a flora and fauna of corresponding variety. There are already known in Colorado over 2,900 species of seed-plants and ferns, a number exceeded by no other state in the union but California and possibly Florida.[1] We have here a field for research and exploration in which very little has been done. In working this field we need have no fear of duplicating

[1] RYDBERG, *Flora of Colorado*, p. xv, 1906.

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work of earlier students. The careful student may expect to discover much that is new to science. In gaining knowledge of his own state he is extending the knowledge of the world.

So far the University of Colorado has put forth but little effort along this line. This little effort, however, has been fruitful in results and promises great things for the future. We need expect nothing spectacular, but we may reasonably expect systematic and persistent effort to be many times repaid. The results accomplished by the expedition to which this account is devoted are simply an illustration of what may be done with a very small expenditure of time and money. The several accounts to follow give a fuller description of a part of the work done. The notes and material of the expedition will be useful in the preparation of more detailed papers to be issued later.

2. Paleontology—Account of Collections Made

By Junius Henderson

The first paleontological work was done just outside the mouth of Little Thompson canyon, northeast of Lyons, in Boulder County. There a *cache* made several years ago was visited and the hidden collection carried away. The collection consisted of some large fossil bivalves (*Inoceramus deformis*) somewhat like clams of the present day. The shells showed a well-marked constriction isolating the umbones from the later accretions of the shell. This peculiarity gives the shell the appearance of having completed its growth and then, as an afterthought, having built a less strongly undulating extension. This same condition sometimes occurs with *I. oblongus* at Fossil Ridge and with *I. sagensis* three miles north of Boulder. It affords a striking example of variation along parallel lines.

Further east in the same valley, below the Hygiene sandstone in the lower third of the Pierre group, a limestone concretion was found containing numerous fossils. Prominent among these were a large number of cephalopod fossils (*Baculites compressus*). There were also other well-known Pierre fossils, including one undetermined bryozoan. So far as known to the writer this is the only one, with a single exception, thus far collected in this region.

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The next camp for paleontological purposes was about seven miles south of Ft. Collins at Trilby Schoolhouse. At this point work was done on Fossil Ridge, which extends north and south parallel with the Colorado & Southern Railway. The ridge consists of a soft sandstone in which are numerous concretions which contain fossils. This place is the type locality for several species and abounds in individuals of other species, particularly the large bivalve, *Inoceramus oblongus*. It is not uncommon to find a dozen or more of these shells six to eight inches in length, in a single concretion two or three feet in diameter. An extensive collection was obtained here. Some of the species obtained had not been previously reported from Colorado. Excellent series of several species were collected showing extremes of variation. Some of these series will be useful for students as illustrating features of interest from the standpoint of evolution. With these collections the University museum now has more than twice as many species as have been recorded for Fossil Ridge.

Fossil Ridge is one of the most important localities in Colorado for invertebrate fossils, yet it has received very meager treatment in the literature of paleontology. With the material now in hand and with a little more field-work to determine some questions of stratigraphy, it will be possible to prepare a valuable report treating the locality with the detail which it deserves.

Along the bluffs of the Cache la Poudre River a short distance southeast of Windsor several hundred specimens of a fossil bivalve, *Veniella humilis*, were collected in an excellent state of preservation. Besides these, there were two almost perfect specimens of another mollusk, *Pholodomya subventricosa*. These were from beds which may be assigned either to upper Pierre or to lower Fox Hills. Above, in undoubted Fox Hills strata, were found a number of species in much better condition than is usual in the friable sandstone of that group.

West of Pawnee Buttes, in eastern Weld County, a general survey of the field was made. Previous expeditions to this region had picked up the most available material so that no extensive collections were obtained. All fossils here are of vertebrate animals. A collection was made consisting of a number of fossil jaw bones of various land forms.

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A large land tortoise, chiseled from the sandstone, was the most important specimen secured. This was taken from a point about eight miles west of the Buttes.

The next work was done in the Laramie group on the east side of Crow Creek about twenty miles northeast of Greeley. Here, naturally, the fossils are of invertebrates. This place, like Fossil Ridge, is the type locality for a number of species, but the fauna is characteristic of fresh and brackish water lagoons. The shells are found in thick layers, many of them in a very fine state of preservation. There is little alteration of the material composing the shells, they weather freely from their matrix, and the species show a resemblance to those of later faunas. Hence these beds have a decidedly Tertiary aspect, but of their Laramie age there is no room for doubt.

On the return trip collections were also made at the mouth of the Thompson and near the confluence of the St. Vrain and the South Platte. At the former station a fossil leaf was found in the Fox Hills sandstone of Cretaceous age. This has been determined by Professor T. D. A. Cockerell as a species of *Ficus*, a genus of trees to which the cultivated fig belongs. Near the mouth of the St. Vrain a large number of fossil shells were obtained. Especially worthy of record is a fine series of oysters,[1] which weathered out from the soft matrix in perfect condition of preservation.

From the foregoing account it will be seen that of all the points visited Pawnee Buttes alone furnishes vertebrate fossils. The other localities are rich in invertebrate material, especially the bivalves, gastropods, and cephalopods. At Fossil Ridge the fullest collections were made. Another expedition should make collections and do stratigraphic work there, in order that this one locality may be thoroughly understood and the results published.

The Fossil Ridge material has not yet been fully examined, but there are at least the following species as the result of the expedition:

Halymenites major Lx.
Chaetetes dimissus White
Membranipora sp.
Serpula sp.
Anatina sp.
Anomia raetiformis Meek

[1] *Ostrea glabra.*

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Callista deweyi M. & H.
Cardium speciosum M. & H.
Glycimeris berthoudi White
Inoceramus oblongus Meek
Inoceramus vanuxemi M. & H.
Inoceramus sagensis Owen
Inoceramus barabini Morton
Ostrea patina M. & H.
Ostrea pellucida M. & H.
Pinna lakesi White
Pteria linguiformis E. & S.
Pteria nebrascana E. & S.
Thracia gracilis M. & H.
Volsella meekii E. & S.
Anchura americana E. & S.
Anchura haydeni White
Anisomyon borealis Morton
Anisomyon centrale Meek
Anisomyon patelliformis M. &. H.
Capulus sp.
Gyrodes sp.
Margarita nebrascensis M. & H.
Baculites compressus Say
Baculites ovatus Say
Placenticeras whitfieldi Hyatt
Placenticeras intercalare M. & H.
Scaphites nodosus Owen

The Crow Creek fossils collected have been fully studied except a good-sized box of *Corbicula*, which may afford some species not yet identified. With this exception the species found are as follows:

Anomia micronema Meek
Corbicula berthoudi White
Corbicula cardiniaeformis White
Corbicula cleburni White
Corbicula fracta Meek
Corbicula macropistha White
Corbicula obesa White
Corbula subtrigonalis M. & H.
Ostrea glabra M. & H.
Bulinus disjunctus White
Campeloma multilineata M. & H.
Goniobasis gracilenta Meek
Goniobasis tenuicarinata M. & H.
Melania wyomingensis Meek
Physa sp.
Tulotoma thompsoni White

3. A New Plant (Ficus) from the Fox Hills Cretaceous

By T. D. A. Cockerell

Among the valuable materials brought home by the expedition is a large fossil leaf, with portions of others, from the Fox Hills Cretaceous. This was found by Judge Henderson near the mouth of Thompson Creek, west of Evans, in the upper part of the beds there exposed. There is no doubt about the age of the rock containing the vegetable remains, as *Cardium speciosum*, a characteristic Fox Hills shell, was found above it. The specimen is of peculiar interest, as no seed-plant has hitherto been described from these beds in Colorado.

Ficus sp. nov.

Represented by the upper portion of a leaf lacking the apex, and the side of the lower portion of another. Leaf large, 12 cm. in diameter,

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probably about 24 cm. long, apparently very thick, with pinnate venation, and the margin nearly entire, but faintly undulate, with slightly indicated and remote teeth near the middle. Lateral veins (secondary) few, alternate, those of either side about 22 mm. apart, leaving the midrib at an angle of about 45°, slightly curved, strongly curved upward toward their ends where they become parallel with the midrib, finally branching, and failing to reach the margin; toward the apex the lateral veins become closer, and in one place two arise nearly together; cross-veins (nervilles), between the laterals, numerous, the principal ones about thirteen in number between two laterals near the middle of the leaf, these cross-veins often bent near the middle, and in general directed somewhat obliquely, neither at right angles to the midrib, nor to the laterals; region between the cross-veins broken into many small mostly quadrangular areas by crossing veinules. The side of the base of another leaf shows the main laterals closer together, the fourth only about 21 mm. from the first (and doubtless nearer at point of origin), and the first only about 6 mm. from the margin, the usual curved veins leaving its lower side at intervals of about 8 mm.

Among living species of *Ficus*, this may be compared with *F. sycomorus* L., but that has no closely adjacent basal laterals. The basal region of our leaf is much more like that of *Artocarpoides conocephaloides*[1] Saporta, but the cross-veins are not so numerous, or quite so oblique, as in that leaf. There is quite a close resemblance to, and very likely real relationship with, *Pterospermites undulatus* Knowlton, but that differs in the structure of the basal parts, is apparently a narrower leaf, and the region between the nervilles is very much less divided into spaces. None of the species of *Ficus* figured by Knowlton from the Montana formation agree at all closely. I had wished to name the plant after its discoverer, but owing to the imperfection of the material, it appears best to withhold a specific name. In doing this, I follow the advice of Dr. Arthur Hollick, who kindly examined a photograph of the specimen.

4. Birds—Account of Species Seen, with Distribution

By Harvey Markman

Traveling from the base of the foothills at Boulder to a point nearly a hundred miles out on the plains a territory was crossed in which the

[1] *Flora fossile de Sezanne*, Pl. VI.

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representatives of certain western species gradually become fewer, and finally disappear, while some eastern forms, seldom seen near the mountains, become quite common. The northern violet-green swallow, although quite common in the foothill canyons, was seen only within a few miles of Boulder. Its near relatives, the cliff and barn swallows, with a much broader range, were seen almost everywhere on the trip. The cliff swallow was particularly noticeable. In the Chalk Bluffs region many clusters of the mud nests of this species were found.[1]

A bird seldom seen on the plains, but more or less common in the foothills, is the canyon wren. This species was observed only at a point four miles west of Trilby, where the spurred towhee was also seen for the last time. Two other wrens were frequently met with, the western house wren in the fringing forests of the St. Vrain and the Little Thompson and the rock wren which extends even to the more barren regions farther east and north. A rock wren's nest, carefully excavated, showed an excellent arrangement for concealing the young birds. The tunnel had the form of a capital Y, the nest, constructed of fine plant fibers, being located at the forking point. The floor of this tunnel and especially of the two branches, was lined with a layer of fine fibers resembling chopped tow. Two of the young fluttered from the nest, when it appeared wholly deserted. A careful examination was now made of the two side passages. Here no less than five young birds were carefully hidden away in the fibrous lining of the nest, which they resembled closely in color and general appearance.

Of the eastern birds that became abundant a distance out from the foothills the crow was perhaps the most conspicuous. This bird was seen along the rivers near New Windsor and also farther east, but was not observed on the high plains. On the other hand, the mocking bird was seen in the Pawnee Buttes region as well as along streams.

Most of the brilliantly colored birds, such as the Bullock oriole, evening grosbeak, lazuli bunting, yellow-throat and chat, were not seen away from the well-watered and timbered country. In drier places, as on the high plains, these species are replaced by birds having a dull

[1] See Fig. 1, Plate II.

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plumage such as Brewer's sparrow, the mountain plover, meadowlark, lark bunting, burrowing owl, and the mocking bird.

The vicinity of Davis' ranch, eight miles west of Pawnee Buttes, was a favorite breeding-place for several species. Many recently deserted nests of Brewer's blackbird were found. Nests of the brown thrasher, mourning dove, white-rumped shrike and Say phoebe were not uncommon among the rocks and evergreens of the gullies. The most common nests were those of the Arkansas kingbird. Practically every cluster of pines had at least a pair of these noisy birds. Nests of Swainson's hawk were found both in trees and among the rocks, one with eggs, one with newly hatched young and others with young well advanced in growth.

On the homeward journey by far the most interesting thing in the way of bird life was a heronry on Crow Creek, where a colony of great blue herons had established themselves in a long narrow grove of cottonwoods which followed closely the winding of the stream bed. High up among the smaller limbs of the tallest trees were perched the large dirty nests, sometimes half a dozen of them in a single tree.[1]

Since the collection of birds was not the primary object of the expedition, the list of those collected or identified is by no means complete. Many of the birds were in the midst of their breeding season, and on this account it was thought best not to do much collecting. Only such specimens were taken as would be new to the University collections. The following list contains the names of the birds collected together with those identified in the field. In most instances they are recorded from the nearest camping-place. With the more common species no attempt is made to give all the localities.

GREAT BLUE HERON. *Ardea herodias.*
Windsor; Crow Creek.

BLACK-CROWNED NIGHT HERON. *Nycticorax nycticorax naevius.*
Windsor.

SORA. *Porzana carolina.*

AMERICAN COOT. *Fulica americana.*
Common on the lakes.

[1] See Fig. 2, Plate II.

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WILSON PHALAROPE. *Steganopus tricolor.*
Windsor.
AMERICAN AVOCET. *Recurvirostra americana.*
Windsor.
SPOTTED SANDPIPER. *Actitis macularia.*
Big Thompson.
KILLDEER. *Oxyechus vocifera.*
Boulder; St. Vrain; Windsor.
MOUNTAIN PLOVER. *Podasocys montana.*
Fossil Ridge; Eastman's Reservoir.
MOURNING DOVE. *Zenaidura macroura.*
Boulder; St. Vrain; Grover.
TURKEY VULTURE. *Cathartes aura.*
St. Vrain; Davis' Ranch.
SWAINSON HAWK. *Buteo swainsoni.*
Davis' Ranch; Pawnee Buttes; Crow Creek.
FERRUGINOUS ROUGHLEG. *Archibuteo ferrugineous.*
Crow Creek.
SPARROWHAWK. *Falco sparverius.*
St. Vrain.
BURROWING OWL. *Speotyto cunicularia hypogaea.*
Trilby; Grover.
BELTED KINGFISHER. *Ceryle alcyon.*
St. Vrain.
RED-HEADED WOODPECKER. *Melanerpes erythrocephalus.*
St. Vrain.
FLICKER. *Colaptes auratus luteus*
Identified by young birds found in a nest on Big Thompson.
RED-SHAFTED FLICKER. *Colaptes cafer collaris.*
St. Vrain.
WESTERN NIGHTHAWK. *Chordeiles virginianus henryi.*
Fossil Ridge.
WHITE-THROATED SWIFT. *Aëronautes melanoleucus.*
Davis' Ranch.
KINGBIRD. *Tyrannus tyrannus.*
Boulder; St. Vrain; Crow Creek.
ARKANSAS KINGBIRD. *Tyrannus verticalis.*
Davis' Ranch; Crow Creek.
SAY PHOEBE. *Sayornis saya.*
Chalk Bluffs; Davis' Ranch.
WESTERN WOOD PEWEE. *Contopus richardsonii.*
St. Vrain.

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DESERT HORNED LARK. *Otocoris alpestris leucolæma.*
Eastman's Reservoir; Grover.
BLACK-BILLED MAGPIE. *Pica pica hudsonia.*
Little Thompson; Crow Creek.
AMERICAN CROW. *Corvus brachyrhynchos.*
Cache la Poudre.
COWBIRD. *Molothus ater.*
Big Thompson.
YELLOW-HEADED BLACKBIRD. *Xanthocephalus xanthocephalus.*
West of Windsor.
REDWINGED BLACKBIRD. *Ægelaius phœniceus.*
Boulder; St. Vrain; Little Thompson.
WESTERN MEADOWLARK. *Sturnella magna neglecta.*
Boulder; St. Vrain; Little Thompson; Grover; Crow Creek.
BULLOCK ORIOLE. *Icterus bullocki.*
Little Thompson; Crow Creek.
BREWER BLACKBIRD. *Euphagus cyanocephalus.*
Davis' Ranch; Crow Creek.
WESTERN EVENING GROSBEAK. *Hesperiphona vespertinus montanus.*
St. Vrain.
HOUSE FINCH. *Carpodacus mexicanus frontalis.*
St. Vrain; Big Thompson.
ENGLISH SPARROW. *Passer domesticus.*
Boulder; Loveland, etc.
WESTERN VESPER SPARROW. *Poœcetes gramineus confinis.*
St. Vrain.
WESTERN LARK SPARROW. *Chondestes grammacus strigatus.*
St. Vrain.
WHITE-CROWNED SPARROW. *Zonotrichia leucophrys.*
St. Vrain.
BREWER SPARROW. *Spizella breweri.*
Slayton's Ranch.
SPURRED TOWHEE. *Pipilo maculatus megalonyx.*
St. Vrain; Foothills west of Trilby.
LAZULI BUNTING. *Cyanospiza amœna.*
St. Vrain.
LARK BUNTING. *Calamospiza melanocorys.*
St. Vrain.
CLIFF SWALLOW. *Petrochelidon lunifrons.*
Boulder; Trilby; Chalk Bluffs, Grover.
BARN SWALLOW. *Hirundo erythrogastra.*
Boulder; Trilby; Grover.

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NORTHERN VIOLET-GREEN SWALLOW. *Tachycineta thalassina lepida.*
Boulder.
WHITE-RUMPED SHRIKE. *Lanius ludovicianus excubitorides.*
Davis' Ranch; Crow Creek.
YELLOW WARBLER. *Dendroica æstiva.*
St. Vrain; Little Thompson; Windsor.
WESTERN YELLOW-THROAT. *Geothlypis trichas occidentalis.*
St. Vrain.
LONG-TAILED CHAT. *Icteria virens longicauda.*
St. Vrain.
WESTERN MOCKING BIRD. *Mimus polyglottos.*
Davis' Ranch; Crow Creek.
CATBIRD. *Galeoscoptes carolinensis.*
St. Vrain.
BROWN THRASHER. *Toxostoma rufum.*
St. Vrain; Davis' Ranch.
ROCK WREN. *Salpinctes obsoletus.*
Boulder; Chalk Cliffs; Eastman's Reservoir; Davis' Ranch.
CANYON WREN. *Catherpes mexicanus conspersus.*
Foothills west of Trilby.
WESTERN HOUSE WREN. *Troglodytes ædon aztecus.*
St. Vrain; Little Thompson.
WESTERN ROBIN. *Merula migratoria propinqua.*
Boulder; St. Vrain.

5. LIST OF MOLLUSKS COLLECTED

BY JUNIUS HENDERSON

The following recent Mollusca were collected by the expedition. The *Sphærium* is a new species.

Strophitus edentulus pavonius Lea
Sphærium hendersoni Sterki
Pisidium compressum Prime
Oreohelix strigosa Gould
Oreohelix strigosa albofasciata Hemphill
Pupilla blandi Morse
Zonitoides arboreus Say
Vallonia cyclophorella Ancey
Lymnæa caperata Say
Lymnæa obrussa Say
Lymnæa palustris Müll.

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Planorbis bicarinatus Say
Planorbis parvus Say
Planorbis trivolvis Say
Physa gyrina Say
Ancylus caurinus Cooper

Results of this collection are recorded in the articles on "The Mollusca of Colorado" which are published in this and the preceding number of these *Studies*.

6. List of Mammals Collected or Noted

By Harvey Markman

The following list includes the mammals collected or carefully noted on the trip. It was found difficult to obtain collections partly owing to the scarcity of mammals and partly because of lack of time. Besides the following a small rodent was collected at Trilby which seems to be a vole, but the specimen was partly eaten while still in the trap and identification is difficult.

White-footed mouse. St. Vrain.
Yellow pocket gopher. Common at Loveland.
Cottontail. Trilby; Davis' Ranch.
Coyote. Fossil Creek.
Skunk. Fossil Creek.
Badger. Fossil Creek.
Prairie dog. Trilby; Grover, etc.
White-tailed jack rabbit. Trilby.
Thirteen-striped gopher. Trilby; Grover, etc.
Packrat. Davis' Ranch.

7. Note on the Butterflies of the Genus Neominois

By T. D. A. Cockerell

The genus *Neominois* (family Satyridæ) is credited in our lists with two species, *N. ridingsii* Edwards, 1865, and *N. dionysius* Scudder, 1878. Several specimens were obtained by the University of Colorado expedition of 1906 ten miles east of Grover, in Weld Co., Colorado, June 29. I had assumed that these were the common *N. ridingsii*, but Mr. S. A. Rohwer pointed out to me that they showed certain resemblances to *N. dionysius*—in their cinereous color, with the basal area of

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the wing often pale and contrasting, and the serrations of the outer edge of the band on the hind wing strongly marked. The size is not too great for *N. ridingsii*. A closer study of the material confirms the original reference to *N. ridingsii*, but at the same time suggests that further collections of *Neominois* will yield facts of great interest from an evolutional standpoint.

The true *Neominois ridingsii* is an insect of the front range in Colorado, ascending to 9000 ft. at Gem Lake, Estes Park (Gillette). It is common in open grassy places at 8,000 ft. It descends, however, to the plains at the base of the mountains, near Denver (Mead) and elsewhere. It goes northward as far as Manitoba.

Neominois dionysius occupies the Great Basin, and was described from the Juniper Mountains, Arizona, and Mount Trumbull, Utah, places not very far apart. It is a larger, gayer, insect, with the ocelli on the front wings very large, and the serrations of the band of the hind wings very marked. The male expands 48–51 mm., the female 55–58½. As might be expected, it occurs also in western Colorado, where it has been obtained by Bruce. On the other side of the Great Basin, in Nevada, there is found a butterfly which Edwards distinguished in 1870 by the name *stretchii*, but which is now placed in all catalogues as a synonym of *N. ridingsii*. This insect is larger than the Colorado form, but has in general the characters of *ridingsii*, not of *dionysius*.

Finally, we have a record[1] of *N. dionysius* from the eastern plains, in Sioux Co., Nebraska.

In all this we appear to have a very clear and interesting case of response to climatic conditions, and probably of the independent development of similar types under similar environments. Mead remarks that the color of the butterflies, as seen near Denver, harmonizes excellently with that of the dry herbage among which they rest, and renders them difficult of detection. It would be of great interest to secure full series from different altitudes and regions, with particulars concerning their surroundings, and see whether several minor races could not be distinguished. It seems probable that the Nebraska "*dionysius*" is derived from *ridingsii*, not from the genuine *dionysius* of the Great

[1] *Cf.* SKINNER, *Syn. Cat. N. A. Rhopalocera*, Suppl. No. 1, p. 114.

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Basin, and represents a further development of the tendencies already evident in the material obtained by Judge Henderson's expedition. The following scheme will indicate the general facts, as I understand them:

Sierra Nevada	Great Basin	Rocky Mountains	Plains East of Rocky Mts.
N. stretchii = topomorph of *ridingsii*	*N. dionysius*	*N. ridingsii*	*N.* derivative of *ridingsii* simulating *dionysius*

8. Botany—Account of Collections Made

By Francis Ramaley

No attempt was made to secure complete collections at the places visited since members of the party were chiefly engaged in other work. Some herbarium specimens were collected, representing the more common plants of typical localities. Notes were taken regarding the distribution of plants on mesas and in gulches. A general survey was made to determine the places where further study should be undertaken.

Collections were made as follows: (*a*) In a cottonwood forest along the St. Vrain Creek about a mile below Lyons, Boulder County—75 numbers; (*b*) Fossil Creek, seven miles south of Ft. Collins, Larimer County—plants of the ridge, 60 numbers, valley plants 51 numbers, roadside plants—35 numbers; (*c*) High plains and the bluffs bordering these about eight miles west of Pawnee Buttes in Weld County—67 numbers; total 288 numbers. So far as possible the plants were collected in duplicate and specimens sent to Professor Aven Nelson for identification. In a few cases material was not in condition and could not be identified with certainty. Most of it was satisfactory, and with even the few specimens collected, a fair idea of the floral characters of the country can be obtained.

In general the plants are those characteristic of the eastern plains region of the state. The climatic conditions are distinctly xerophytic, hence dry-country plants[1] are the rule except in river bottoms. Plants of the pulse family are especially conspicuous in most of the dry locali-

[1] See Fig. 2, Plate I.

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ties. Particular mention may be made of the loco weeds[1] which occur on plains and bluffs. Another plant of this family, a species of *Psoralea*,[2] is the dominant plant on the mesas and ridges and much of the plains formation in early summer. It has somewhat the appearance of sweet clover or alfalfa but grayish in color and with few leaves. Along with the *Psoralea* are found one or more shrubby species of wormwood.[3]

Well-developed river-bottom forests[4] occur along the St. Vrain Creek below Lyons and especially along the Poudre River near Windsor there is some fringe of forest[5] accompanying all of the water courses. At the first point named above the trees are chiefly narrow-leaf cottonwoods with some western cottonwoods.[6] Other trees are small birches,[7] alders[8] and box-elders.[9] The Poudre forest is made up of the common western cottonwood together with box-elders and two or three willows. Here there is often a dense undergrowth of rank herbs and such trailing and creeping plants as hops, clematis and Virginia creeper[10] and poison ivy.[11]

The total number of trees and shrubs in the region studied is small. Besides those species which occur in river bottoms there are certain trees which grow only on the bluffs and near the heads of gulches. An especially interesting place is the bluff at the southern limit of the high plains about eight miles west of Pawnee Buttes. Here the western cedar[12] was found and also one of the five-leaved pines.[13] The occurrence of the latter is particularly noteworthy as this tree has not been reported in Colorado except from high mountain stations. The shrubs growing along these bluffs are the skunk bush[14] and the mountain mahogany.[15] Following is a list of all the woody plants collected by members of the party.

[1] Species of *Astragalus* and *Aragallus*.
[2] *Psoralea tenuiflora* Purah.
[3] *Artemisia*.
[4] See Fig. 3, Plate I.
[5] See Plate II.
[6] *Populus sargentii* Dode=*P. occidentalis* (Rydb.) Britt.
[7] *Betula fontinalis* Sarg.
[8] *Alnus tenuifolia* Nutt.
[9] *Acer negundo* Linn.
[10] *Parthenocissus vitacea* Hitch.
[11] *Rhus rydbergii* Small.
[12] *Juniperus scopulorum* Sargent.
[13] Probably *Pinus flexilis*.
[14] *Rhus trilobata*.
[15] *Cercocarpus parvifolius*.

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Woody plants of river bottoms and moist gulches:

Salix amygdaloides Anders.
Salix exigua Nutt.
Populus angustifolia James
Populus sargentii Dode = *P. occidentalis* (Rydb.) Britt.
Alnus tenuifolia Nutt.
Betula fontinalis Sarg.
Clematis ligusticifolia Nutt.
Ribes vallicola Greene
Rhus rydbergii Small
Acer negundo Linn.
Parthenocissus vitacea Hitch.
Vitis vulpina Linn.

Woody plants of dry hills and bluffs:

Pinus flexilis James ? (collected without cones)
Juniperus scopulorum Sarg.
Ribes cereum Dougl.
Cercocarpus parvifolius Nutt.
Rhus trilobata Nutt.

The collection of plants made at Pawnee Buttes is of interest because it represents the flora of the driest part of the high plains. Nothing seems to have been published thus far concerning the plants of the district. On this account a list of the specimens collected is given in full, so far as determinations have been made.

List of plants collected about eight miles west of Pawnee Buttes:[1]

Pinus flexilis James
Juniperus scopulorum Sarg.
Tradescantia scopulorum Rose
Agropyron sp.
Bulbilis dactyloides (Nutt.) Raf.
Eriocoma cuspidata Nutt.
Koeleria cristata (Linn.) Pers.
Stipa spartea Trin.
Zygadenus falcatus Rydb.
Eriogonum alatum Torr.
Eriogonum effusum Nutt.
Atriplex sp.
Eurotia lanata (Pursh) Moq.

[1] Determinations in most cases were made by Professor Aven Nelson of the University of Wyoming.

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Abronia micrantha A. Gray
Paronychia pulvinata A. Gray
Delphinium geyeri Greene
Lesquerella montana (A. Gray) S. Wats.
Ribes cereum Dougl.
Cercocarpus parvifolius Nutt.
Astragalus adsurgens Hook.
Astragalus microlobus A. Gray
Astragalus pectinatus A. Gray
Astragalus multiflorus A. Gray
Petalostemon sp.
Psoralea tenuiflora Pursh.
Linum aristatum Engelm.
Linum puberlum (Engelm.) Heller
Euphorbia fendleri (T. & G.) Small
Euphorbia robusta (Engelm.) Small
Rhus trilobata Nutt.
Malvastrum dissectum (Nutt.) A. Nels.
Opuntia polyacantha Haw
Opuntia rhodantha K. Sch.
Echinocereus viridiflorus Engelm.
Gaura coccinea Nutt.
Gaurella guttulata (Geyer) Small
Galpinsia lavandulæfolia (T. & G.) Small
Meriolix serrulata (Nutt.) Walp.
Gilia iberidifolia Benth.
Phlox andicola (Britt.) E. Nels.
Allocarya scopulorum Greene
Oreocarya suffruticosa (Torr.) Greene
Phyla cuneifolia (Torr.) Greene
Pentstemon albidus Nutt.
Thalesia fasciculata (Nutt.) Britt.
Artemisia aromatica E. Nels.
Erigeron pumilus Nutt.
Hymenopappus cinereus Rydb.
Lygodesmia juncea (Pursh) D. Don
Thelesperma intermedium Rydb.
Townsendia grandiflora Nutt.

In the above list it will be seen that no species new to science were obtained. However, the known range of some of the species was con-

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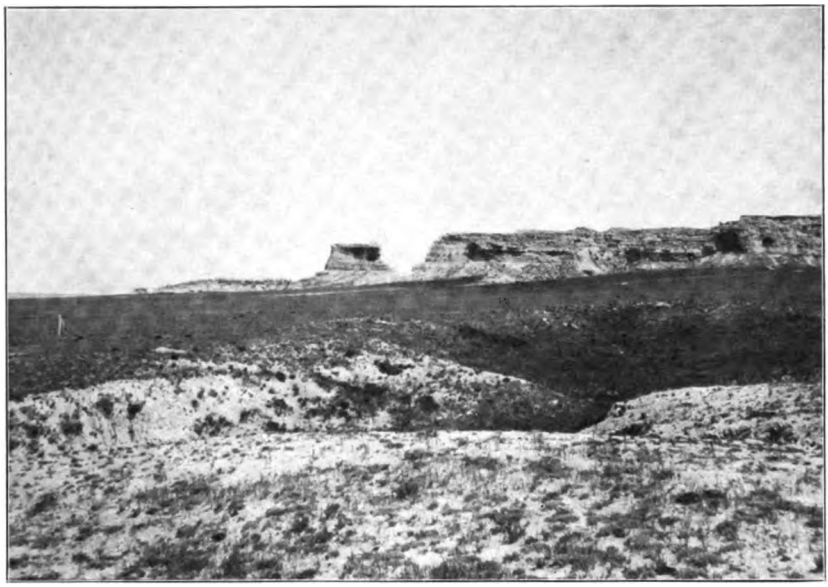

FIG. 1

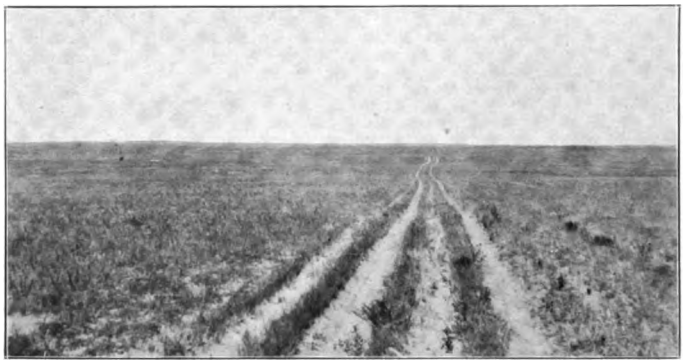

FIG. 2

FIG 3

SCIENTIFIC EXPEDITION TO NORTHEASTERN COLORADO

PLATE I

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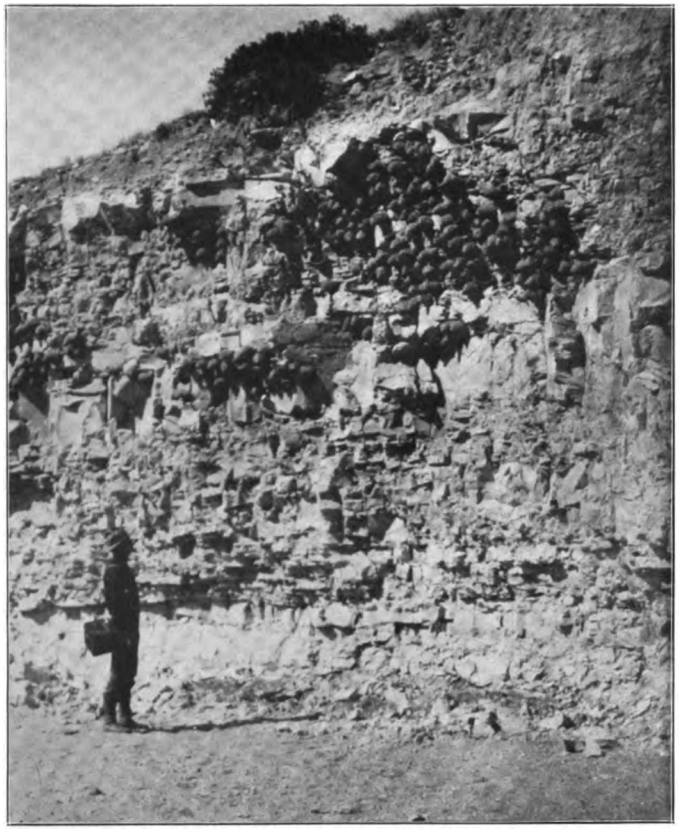

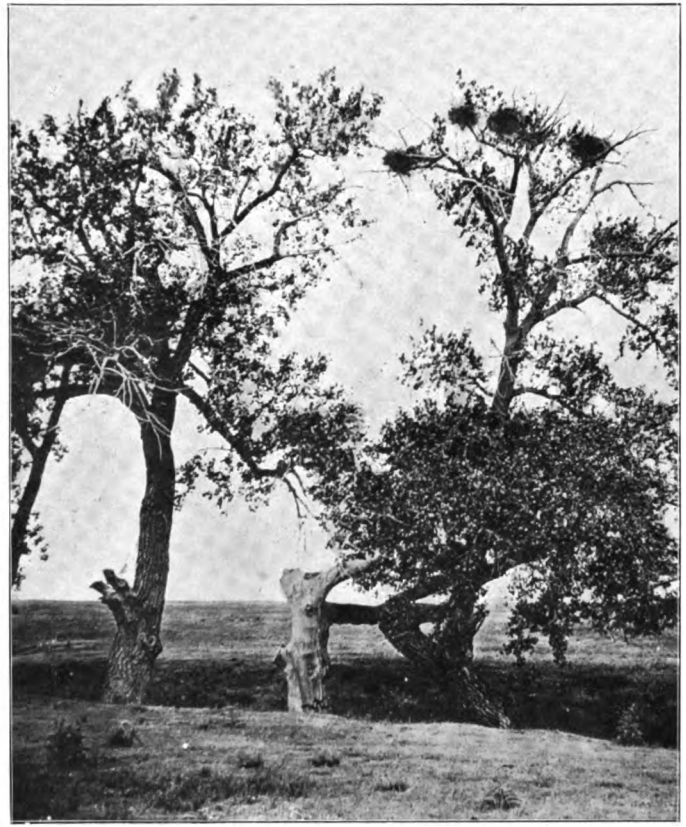

FIG. 1

FIG. 2

SCIENTIFIC EXPEDITION TO NORTHEASTERN COLORADO

PLATE II

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siderably extended by these collections. From the specimens at hand a general idea of the flora can be obtained and further collections can be intelligently undertaken. As the specimens were all gathered about the last of June it is desirable that future and more complete collections be made later in the season.

EXPLANATION OF PLATES

PLATE I

FIG. 1.—Bluffs at southern edge of high plains east of Grover, Weld Co., Colo. These bluffs consist of sandstones and clays belonging to the Loup Fork and White River beds. They contain numerous vertebrate remains. The illustration shows how portions of the bluffs may be cut off as isolated buttes. The region in the foreground belongs to the eroded area of the South Platte River valley.

FIG. 2.—View on the high plains to the north of the bluffs shown above. Note the very flat character of the country with its sparse vegetation of coarse composites and bunch grass.

FIG. 3.—River-bottom forest on the bank of the Cache la Poudre River near Windsor, Colo. The forest varies from fifty to a few hundred feet in width. The trees are chiefly cottonwoods and willows.

PLATE II

FIG. 1.—Nesting-site of cliff swallows at Chalk Bluffs in Weld Co., Colo., near Cheyenne, Wyo. In these bluffs no fossils were found by the expedition.

FIG. 2.—Cottonwood trees on Crow Creek with herons' nests in the upper branches. Note the stunted character of the trees. Along many of the creeks there are just such narrow lines of trees forming no true river-bottom forests.

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THE MOLLUSCA OF COLORADO. PART II[1]

By Junius Henderson

Genus **OREOHELIX** Pilsbry

Oreohelix strigosa Gld. Fig. 3.

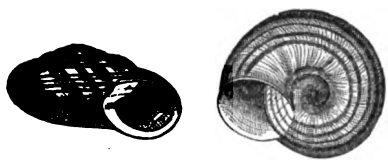

Fig. 3.—Oreohelix strigosa.

Patula strigosa. Grand River, Binney **5**, 623. Blue River and Saguache, Yarrow **68**, 930. North Park (E. A. Barber), Boulder and Magnolia (Henderson), Black Lake Creek (Cockerell), Larimer County (S. M. Edwards), Vanatta Mss.

Patula strigosa hemphilli Newc. Williams Canyon, Binney **6**, 168. See Cockerell **14**, 102; Sampson **46**, 102; Stearns **52**, 62.

Form *globosula* Ckll. (Described from one immature specimen) Black Lake Creek, Cockerell **14**, 101; Binney **7**, 170.

The confusion in the literature of this genus makes it impossible to be certain about the records of the various subspecies, and the large number of named forms of less than specific or subspecific value, some of which, at least, have been described from single specimens, has not assisted in bringing order out of chaos. The differences in color, number and width of bands, elevation of spire and deflection of last whorl toward the aperture are so marked even in specimens found together, and various forms which appear quite distinct when viewed separately pass into each other by gradation so insensible when considered in large series, that their separation becomes more a matter of opinion than of fact. Even such extreme forms as *hemphilli* are found in large series of specimens to pass into typical *strigosa* in such a way that no line can be drawn between them.[2] It is difficult to say whether some of the forms should be considered forms of *strigosa* or *cooperi*, or whether they should be designated as varieties, subspecies, mutants or forms. It was once said that *cooperi* was the common form in Colorado but the majority of specimens from east of the Front Range are now referred to *strigosa* and its varieties, while we have seen no living *cooperi*. The majority of specimens examined by the writer have two rather wide spiral bands, a few have one or two fine additional lines and a very few immature specimens have quite a number of obscure lines on the base. The species is common in the foothills and mountains from Boulder to Lyons and southward. We have found it fossil at Bear Canyon. Our finest specimens were collected

[1] Part I of this paper was published in Vol. IV of these Studies, pages 77 to 96 inclusive, and included an introduction, bibliography, locality list, key to species and an annotated catalogue of the *Pelecypoda*. In the citations of former records herein the figures in bold-faced type refer to the numbers of the publications listed in the bibliography in Part I, and the figures in light-faced type refer to the pages. The illustrations in this part are all electrotyped from originals used in the publications of Smithsonian Institution, by courtesy of the authorities of that institution. The introductory remarks in Part I included a list of the species added to the recorded fauna by this paper. Since it was published records of four more species have been added, namely: *Bifidaria pilsbryana* St., *B. hordeacella* Pils., *B. procera* Gld., and *Lymnaea leai* Baker, besides the hothouse specimen of *Vitrea alliaria* Drap.

[2] Pilsbry, *Man. Conch., VIII*, p. 115; Stearns 50, 96, 51, 745, 746.

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by Mr. A. Mackenzie on Mt. Audubon, altitude 11,000 feet, others were collected at Can yon City by Miss Voight, and dead specimens near Glenwood springs by Messrs. Horace. G. Smith and Will Huestis.

Oreohelix strigosa albofasciata Hemp.

A few specimens referred to this form were collected near Glenwood Springs by Mr. H. G. Smith, and at Lyons by the writer. In both instances they were associated with typical *strigosa*.

Oreohelix strigosa depressa Ckll.

Durango, Cockerell **12**, 8; **14**, 102; **23**, 107. Foothills near Boulder (Ralph V. Mann), Vanatta Mss. Described and recorded by Prof. Cockerell as a form of *cooperi*, but now considered a variety of *strigosa*.

Mr. S. R. Rohwer has collected a specimen at Boulder with the spire nearly flat.

Oreohelix strigosa concentrata Dall.

Colorado, Dall **33**, 1; **34**, 336. Chaffee County, Cockerell **29b**, 106, 107.

Patula strigosa minor Ckll. Egeria **23**, 175; **28**, 135.

This is probably the same as Prof. Cockerell's var. *minor*, in which case, if the species is recognizable from Cockerell's description, the latter name would supersede Dall's.

Oreohelix cooperi W. G. B. Fig. 4.

Dead shells near Naomi, Black Lake Creek, top of range between Wheeler and Red Cliff, Squaw Creek, Grand River at Glenwood Springs (1 alive), North Mam Creek,

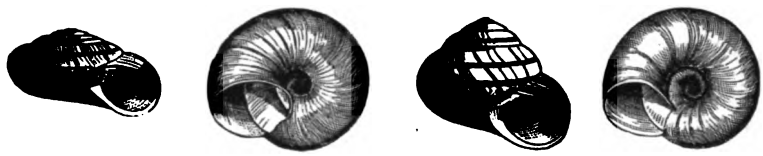

FIG. 4.—Oreohelix cooperi.

near Buzzard Creek (one alive); Plateau Creek, West Fork Clear Water Creek and White Earth, Cockerell Mss. Wheeler and Custer County (Cockerell), Vanatta Mss.

Patula cooperi. Grand River, Binney **5**, 623. Hot Sulphur Springs, Blue River Valley, Lakes in San Luis Valley and N. E. Colorado, Ingersoll **35**, 396. Floyd's Hill, Clear Creek and Canyon City, Ingersoll **37**, 131.

Patula strigosa cooperi. Gilpin Gulch, Williams Canyon, Morrison, Gunnison, Middle Park, North Park, Micawber Mine, Kremmling, Hardscrabble Canyon, Black Lake Creek, Pottery Pass, Red Cliff, Glenwood Springs, Buzzard Creek, Surface Creek, White Earth Creek, Lyons, St. Vrain Canyon, Egeria, near Durango, and Custer, Grand, Routt, Pueblo, Summit, Eagle, Garfield, Mesa, Delta and Gunnison Counties, Cockerell **14**, 102; **22**, 62.

Patula strigosa cooperi. Form *typica*, Ckll., Canyon City, Manitou, etc.; form *trifasciata* Ckll., Mesa County; form *confluens* Ckll., Custer, Garfield, and Mesa Counties; form *elevata* Ckll., Delta Co.; form *depressa* Ckll., Durango; form *major* Ckll., North Mam Creek; form *minor* Ckll., Egeria; Cockerell **12**, 8; **14**, 102; **23**, 175; Binney **7**, 173.

Helix cooperi. Abundant in Williams Canyon, Beauchamp **2**, 53.

Oreohelix cooperi mut. *sinistrorsa*. A sinistral specimen found by Prof. Cockerell's brother in Southern Colorado. Cockerell Mss.; Pilsbry **39**, 83.

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We have received dead specimens collected by Professor F. H. Hopkins at Meeker and by Mr. A. Dakan at Muddy Creek, Bear River above Hayden and above Steamboat Springs, and 15 miles north of Craig, all in the western part of the state, and found one lot of five semi-fossil specimens at Boulder. Some of the foregoing records probably refer to *strigosa*, but they are here inserted just as they occur in the literature. The fact that few live ones have been found appears to indicate that it may be on the rapid road to extermination through a considerable part of its range, a matter well worthy of investigation. Professor Cockerell suggests to the writer that its higher spire renders it less fitted than *strigosa* to survive in a semi-arid country, because of the greater difficulty of getting under rocks, etc., to avoid the dry heat. This, however, would not account for the extinction of *haydeni*, which is a depressed form. An investigation of species recently extinct or approaching extinction may throw some light upon recent changes in climate.

Oreohelix cooperi trifasciata Ckll.

Mesa County, Cockerell **12**, 8; **14**, 102; **23**, 175. Gleneyre (S. M. Edwards), Vanatta Mss.

Oreohelix haydeni Gabb.

Glenwood Springs (Silas L. Schumo), Vanatta Mss.

We have just received from Professors E. Bethel and G. L. Cannon about 35 specimens of this species which call to mind Binney's assertion that it must be considered a variety of *strigosa*. The series passes from very strongly ribbed specimens by minute gradation to those almost entirely smooth. The color bands, when not obliterated by bleaching, are as in ordinary *strigosa*. The spire varies from greatly depressed to highly elevated forms, thus connecting *strigosa* and *cooperi*. The specimens referred to above were found fossil together at Glenwood Springs by Miss Mabel Stearns. This affords food for thought, especially when considered in connection with the facts that *haydeni* seems nearly extinct, *cooperi* is apparently extinct through a great portion of its range, and *strigosa* seems much less common in many places than formerly. It is not at all unlikely that further field-work may bring to light the origin and the beginning of the extinction of these forms.

Genus **THYSANOPHORA** Strebel & Pfeiffer.

Thysanophora ingersolli Bland.

San Juan, Custer and Mesa Counties, Pilsbry and Johnson **43**, 15. Near Buzzard Creek, West Fork Clear Water Creek, and Ouray, Cockerell Mss. Clear Water Creek and Custer County (specimens from Cockerell), Vanatta Mss.

Microphysa ingersolli. Baker's Park, Cunningham Gulch, Animas Valley and North Park, up to 11,000 feet, Ingersoll **35**, 389, 398. Saguache Mts., Ingersoll **37**, 130. Saguache Mts., Las Animas and LaPlata Counties, Howardsville and Cunningham Gulch, Binney **6**, 170. Western Custer County and Grand Mesa, Cockerell **22**, 62, 65.

Pyramidula ingersolli. San Juan, Custer and Mesa Counties, Cockerell **14**, 103.

We have found a few above Eldora, at an altitude of over 9,000 feet, and four small specimens at Boulder. The latter were accidentally destroyed.

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Genus **POLYGYRA** (Say) Pilsbry

Polygyra monodon Rack. Fig. 5.

FIG. 5.—Polygyra monodon.

Stenotrema monodon, Colorado Springs, Yarrow **68**, 929.
Helix monodon, Colorado Springs, Cockerell **14**, 103.

This should probably not be included in the Colorado molluscan fauna. It is an eastern species, collected long ago and not since reported from this state. We see no reason to doubt the identity, but the specimens must have been accidentally introduced and have evidently not become incorporated into the permanent fauna.

A box full of *P. clausa* Say was found in the Maxwell collection in the University Museum containing a card bearing the word "Colorado," but it was not in Mrs. Maxwell's handwriting and the source of the label is unknown. So conspicuous a species would probably not occur in such numbers without being observed by other collectors, and if Mrs. Maxwell had collected these in Colorado there would probably have been other common land shells with them.

Genus **PUPOIDES** Pfeiffer

Pupoides marginatus Say.

Pupa fallax Say. South Park, Twin Lakes and Pagosa, Yarrow **68**, 926.
Pupa arizonensis Gabb. (not Pils. & Van.). "From El Paso County, according to Tryon, but not found since." Cockerell **22**, 63. This may be *hordaceus*.
Trinidad (Pilsbry), Vanatta Mss.

Pupoides hordaceus Gabb. Fig. 6.

FIG. 6.—Pupoides herdaceous.

Trinidad (Pilsbry), Vanatta Mss.
Pupa hordacea Gabb. Williams Canyon, Sampson **46**, 102.
Pupa arizonensis W. G. B. and *Pupa saxicola* Ckll., Colorado, Sterki **57**, 4.
Pupa gabbi mexicanorum Dall. Round Mt., Cockerell **29**, 143.
Pupa arizonensis saxicola Ckll. Round Mt., Cockerell, *Zoe*, Vol. II, 1891, p. 18. Placed under *hordaceus* with hesitation, adding, "We know nothing of the Colorado shells called *P. arizonensis* var. *saxicola* by Mr. Cockerell," Pilsbry & Vanatta **44**, 588, 589. Dr. Sterki writes Prof. Cockerell that he has two specimens, dead and somewhat weathered, short as compared with some New Mexico specimens and with slighter, more crowded striæ.

Genus **PUPILLA** Leach

Pupilla muscorum Linne

Blue River Valley and Los Pinos Agency, Ingersoll **35**, 390. Twin Lakes, 9,500 ft., Yarrow **68**, 927. Greeley (L. C. Wooster), Estes Park (Rev. E. H. Ashmun), Black Lake Creek (Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Pupa muscorum. Colorado, Pilsbry **38**, 45; Pilsbry & Johnson **43**, 20. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Round Mt., with one specimen of var. *albina* Menke, Cockerell Mss.

We have found it fossil at mouth of Bear Canyon, three miles south of Boulder, and have received specimens collected by Prof. Cockerell at Lake George and by Mr. D. M. Andrews at Magnolia. Prof. E. Bethel has sent us a few specimens found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte near Denver.

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Pupilla blandi Morse.

Clear Creek, Cunningham Gulch, Animas Valley and Rio LaPlata, Ingersoll **35**, 391. Twin Lakes, Yarrow **68**, 927. Black Lake Creek, Cockerell Mss. Pike's Peak (E. Hall), North Park (E. A. Barber), Estes Park (Rev. E. A. Ashmun), Buzzard Creek, Black Lake Creek, Mesa and Custer Counties (Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Pupa blandi. Colorado, Binney **6**, 188; Dall **34**, 367; Pilsbry & Johnson **43**, 20; Surface Creek, Cockerell **22**, 65.

Form *obtusa* Ckll. "Broader in proportion to its length than the type," near Micawber Mine, Cockerell **24**, 39; Pilsbry & Johnson **43**, 20; Pilsbry & Vanatta **44**, 605.

"The species of *Pupa* are numerous and puzzling. The common species in Custer Co. is *P. blandi* Morse, which presents various forms, one of which Mr. C. F. Ancey, to whom specimens were sent, refers to *P. bigranata* Rossm. Probably they are all referable to *P. marginata* Drap. as varieties." Cockerell **22**, 62.

Collected at Magnolia by Mr. D. M. Andrews; on the Niobrara limestone ridge south of Left Hand Creek north of Boulder by Prof. Cockerell and the writer; at Tolland by Prof. E. Bethel and by the writer at Boulder and Eldora.

Pupilla sonorana Sterki.

Estes Park (Rev. E. H. Ashmun), Vanatta Mss.

FIG. 7.—Bifidaria armifera

Genus **BIFIDARIA** Sterki[1]

Bifidaria armifera Say. Fig. 7.

Trinidad (Pilsbry), Vanatta Mss.

We have found it fossil at mouth of Bear Canyon south of Boulder but find no published record for the state.

FIG. 8.—Bifidaria pentodon.

Bifidaria pentodon Say. Fig. 8.

Pupa montanella Ckll. Western Custer County, Cockerell **22**, 63 (no description accompanying the latter name, it is a *nomen nudum*, and is in any event a synonym, Pilsbry & Vanatta **44**, 608). Prof. Cockerell says he has since compared his figure and notes and finds the shell to be the real *pentodon* as recently restricted by Pilsbry and Vanatta.

Bifidaria pilsbryana St.

Trinidad (Pilsbry), Vanatta Mss.

Bifidaria hordeacella Pils.

Trinidad (Pilsbry), Vanatta Mss.

Bifidaria procera Gld.

Trinidad (Pilsbry), Vanatta Mss.

FIG. 9.—Vertigo ovata.

Genus **VERTIGO** Draparnaud

Vertigo ovata Say. Fig. 9.

Twin Lakes and Saguache, Yarrow **68**, 927, 928. Fossil at West Cliff, Cockerell **29**, 143. Trinidad (Pilsbry), Vanatta Mss.

Vertigo ovata antiquorum Ckll. Subfossil at Grape Creek, Cockerell Mss.

[1] The records of *B. pilsbryana*, *hordeacella* and *procera* have just been received and consequently do not appear in the key included in Part I of this paper.

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Vertigo ventricosa elatior Sterki.

One specimen was collected this year at Lake George by Professor Cockerell and identified by Mr. Vanatta.

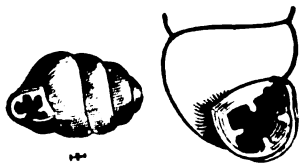

FIG. 10.—Vertigo gouldi.

Vertigo gouldi Binn. Fig. 10.

Colorado, Sterki **54**, 31; Binney **7**, 199. Fossil at West Cliff, Cockerell **29**, 143.

Vertigo tridentata Wolf.

South Park (No. 29667 U. S. Nat'l Mus.), Sterki Mss., **55**, 135; Binney **7**, 196.

Vertigo modesta corpulenta Morse.

Colorado, Dall **34**, 367.

Pupa corpulenta. Los Pinos Agency and divide S. W. of Los Pinos, Ingersoll **35**, 392. Custer and Delta Counties, Cockerell **22**, 62, 65. North Park, Pilsbry & Johnson **43**, 21.

One specimen was collected recently by Prof. Cockerell at Lake George and identified by Mr. Vanatta.

Vertigo modesta corpulenta parietalis Ancey.

Colorado, Pilsbry & Vanatta **44**, 609. Delta and Custer Counties (Cockerell), North Park (E. A. Barber), Vanatta Mss.

Pupa corpulenta parietalis. Black Lake Creek, Cockerell Mss.

Dall includes *ingersolli* Ancey (=*concinnula* Ckll.) and *coloradensis* Ckll. under the name *decora* Gld. (=*modesta* Say) for Colorado, Dall **34**, 367; see Cockerell's comments, **28**, 135.

It would be no great sin to consider the last two synonyms of *modesta*.

Vertigo coloradensis Ckll.

Near Swift Creek. Pilsbry & Vanatta **44**, 603, 609; Cockerell **28**, 135; Sterki **57**, 5.

Pupa coloradensis. Colorado, Cockerell **22**, 63; Brit. Nat., 1891, p. 100; Binney **7**, 191; Pilsbry & Johnson **43**, 21.

Vertigo concinnula Ckll.

Animas Valley, Rio LaPlata and Cunningham Gulch, Cockerell **28**, 135. Custer and Summit Counties, Pilsbry & Vanatta **44**, 600. Summit and Custer Counties and Black Lake Creek (Cockerell), Vanatta Mss.

Vertigo californica Ing. Blue River Valley, Los Pinos Agency, S. W. of Los Pinos, Howardsville, Animas Valley and Rio LaPlata, Ingersoll **35**, 392.

Vertigo decora var. *concinnula* Ckll. Colorado, Dall **34**, 367.

Pupa concinnula Ckll. "Colorado at high elevations. (*V. ingersolli* Ancey, unpublished, with varieties *haydeni* and *accedens* Anc., belong here.)" Pilsbry & Johnson **43**, 21. See Sterki **57**, 5.

Var. *haydeni* Ancey. Cunningham Gulch, distinguished by three parallel teeth on inside of outer wall of aperture, Cockerell Mss.

We recently collected four specimens at Eldora.

FIG. 11.—Vertigo milium.

Vertigo milium Gld. Fig. 11.

Kremmling, Cockerell Mss.

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Genus **COCHLICOPA** (Fér.) Risso.

Cochlicopa lubrica Müll. Fig. 12.

FIG. 12.—Cochlicopa lubrica.

Near West Cliff and Swift Creek, Cockerell **12**, 9; **22**, 62. Buzzard Creek, Cockerell **15**, 360. Plateau Creek and subfossil at Cotapaxi, Cockerell Mss. Custer County, Buzzard Creek and Colorado Springs (Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Cionella subcylindrica L. Clear Creek, Ingersoll **35**, 391.

Ferussacia subcylindrica L. Williams Canyon, Sampson **46**, 102.

Cionella lubrica. White Earth, Dall **34**, 353.

We have found about 20 specimens at Boulder.

Genus **VALLONIA** Risso.

Vallonia pulchella Müll. Fig. 13.

South Park, Yarrow **68**, 932. North America east of the Rocky Mts., Sterki **58**, 16. Rio LaPlata, Dall **34**, 366. Boulder County (Cockerell), Vanatta Mss.

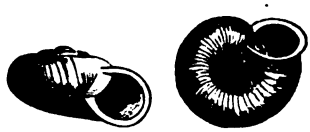

FIG. 13.—Vallonia pulchella.

Helix pulchella. Estes Park, Binney **5**, 623. Blue River Valley, West of Saguache, Los Pinos Agency, Howardsville, Rio LaPlata and North Park, Ingersoll **35**, 399.

We suspect that the early records, antedating the description of *gracilicosta* and *cyclophorella*, probably refer to the latter. Professor Cockerell, however, has recently found true *pulchella* on a vacant lot in Boulder. On the same lot occurs the introduced *Agriolimax agrestis*, which suggests that this *Vallonia* may have been also introduced. One specimen of *pulchella* was found also in Boulder, near Boulder Creek, last spring, by Mr. Sievert R. Rohwer.

Vallonia gracilicosta Reinh.

Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Found fossil at Bear Canyon, three miles south of Boulder, with a number of species which still survive in the region. Some worn specimens collected by Prof. Cockerell at Lake George we refer to this species with some hesitation, and we have received two specimens from Prof. E. Bethel, found fossil by Prof. Geo. L. Cannon in ancient overwash of the Platte River near Denver, associated with several other species.

Vallonia cyclophorella Anc.

North Park (E. A. Barber), Swift Creek, Buzzard Creek, Clear Lake Creek, Divide Creek and Cattle Creek (Cockerell), Vanatta Mss. West Cliff, Sterki **56**, 101; **59**, 272. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Salida, North Mam Creek, Round Mt., North Park and Los Pinos Agency, Cockerell Mss.

Vallonia pulchella costata Müll. Williams Canyon, Sampson **46**, 102.

Helix pulchella var. *costata*. Micawber Mine, Rock Creek, Kremmling, Pueblo County, near Salida, Black Lake Creek, Buzzard Creek and near Cattle Creek, Cockerell **14**, 103. Custer County, Cockerell **22**, 62.

Along the foothills of Boulder County, and perhaps throughout the state, this is our most common land snail and the only Vallonia at all common. It extends well into the mountains, where we have found it near Eldora, 8,500 feet, and Mr. D. M. Andrews collected a few at Magnolia. Probably most of the Colorado records of *pulchella* belong here.

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Genus **VITREA** Fitzinger [1]

Vitrea hammonis Strom.

Colorado, Pilsbry & Johnson **43**, 25. Buzzard Creek, Divide Creek and Black Lake Creek (specimens from Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Zonites viridula Menke. Blue River Valley, Saguache Creek, 20 miles west of Saguache, Cascade Creek in Animas Valley and Rio LaPlata, always at foot of mountains, wet, shaded ground, beside running water, Ingersoll **35**, 393. South Park, Yarrow **68**, 934.

Hyalina radiatula Alder. Custer, Pueblo, Mesa and Garfield Counties, Cockerell **22**, 62, 64. Buzzard Creek, Cockerell **15**, 360.

Hyalina radiatula viridescenti-alba Jeffreys. Custer and Mesa Counties, Cockerell **14**, 101; **22**, 62; Buzzard Creek, Cockerell **15**, 360.

Vitrea radiatula Alder. Subfossil at Grape Creek, Cockerell Mss.

Genus **VITRINA** Draparnaud

Vitrina alaskana Dall. Fig. 14.

Vitrina pfeifferi Newc. Head of Gunnison River, Binney **5**, 623. Los Pinos Agency, divide southwest of Los Pinos, Howardsville, Rio LaPlata, head of Mineral Creek and head of Gunnison River, Ingersoll **35**, 394. Ft. Garland and Twin Lakes, Yarrow **68**, 932. Colorado, Binney **6**, 88; Pilsbry & Johnson **43**, 25. East Fork Arkansas River in Lake County, near Cattle Creek, near Mam Mts., Breckenridge and Rock Creek, Cockerell **22**, 62; **14**, 100. Wet Mt. Valley, Northrop, near Zion Peak, West Ten Mile Creek, Straight Creek, Black Lake Creek, near Cattle Creek, near head North Mam Creek, north of Buzzard Creek, West Fork Clear Water Creek, Surface Creek and East Twin Mesa, Cockerell Mss.

FIG. 14.—Vitrina alaskana.

Vitrina limpida Gld. Clear Creek, Howardsville and Animas Valley, Ingersoll **35**, 394. South Park, Yarrow **68**, 933. Dillon, Swift Creek, Grand Mesa, Wales Canyon, Cottonwood Gulch, near Mam Mts. and West Fork Surface Creek, Cockerell **14**, 100. Colorado, Dall **34**, 365.

V. pellucida. Custer and Saguache Counties, Cockerell **22**, 62, 64.

Vitrina alaskana Dall. Mesa and Saguache Counties, Black Lake Creek and Buzzard Creek (Cockerell), North Park (E. A. Barber), Vanatta Mss.

This species is rather common from Boulder to an altitude of about 11 000 feet. The finest specimens we have found were collected at Eldora. It seems probable that Dr. Dall's name proposed in his paper on the Mollusks of Alaska, should stand for this well-known species, as *pfeifferi* is said to be preoccupied.

Genus **EUCONULUS** Reinhardt

Euconulus trochiformis Dall. Fig. 15.

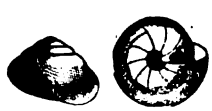

FIG. 15.—Euconulus trochiformis.

Euconulus fulvus Drap. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Rio LaPlata, White Earth, Wet Mt. Valley, West Ten Mile Creek, Straight Creek, Divide Creek, North Mam Creek, North Park, subfossil at Grape Creek, Cockerell Mss. North Park (Barber), Buzzard Creek, Black Lake Creek and Swift Creek (Cockerell), Vanatta Mss.

Zonites fulvus. Hot Sulphur Springs, mouth of Blue River,

[1] **Vitrea alliaria** Drap.

A single specimen was found in February, 1907, by Mr. Guy H. Mason, at Knudson's greenhouse, Boulder, and presented to the University museum by Professor Cockerell. The identity has been confirmed by Dr. W. H. Dall. This being a European species and as yet found only in a greenhouse, it can hardly be considered a member of our Colorado fauna, but is noted here because it may easily become incorporated into the fauna by escaping from hothouses, as *Agriolimax agrestis* was probably introduced.

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20 miles west of Saguache, Clear Creek, Howardsville and Empire, most abundant at 9,000 to 10,000 feet, Ingersoll **35**, 393; **37**, 131. South Park and Twin Lakes, Yarrow **68**, 934.

Hyalina fulva chersina Say. White Earth River, near West Cliff, Micawber Mine (10,000 ft.), Kremmling, Egeria, Buzzard Creek, Surface Creek, Divide Creek and Black Lake Creek, Cockerell **14**, 101.

Conulus fulvus. Near Dillon, Cockerell **15**, 360. Custer, Summit, Garfield, Mesa and Delta Counties, Cockerell **22**, 62, 64, 65. Egeria **23**, 175.

Found by Mr. D. M. Andrews at Magnolia; by Prof. Cockerell at Lake George; by Sievert R. Rohwer at Florissant; by Prof. Bethel at Granby; and by the writer at Eldora.

Genus **ZONITOIDES** Lehmann

Zonitoides arboreus Say. Fig. 16.

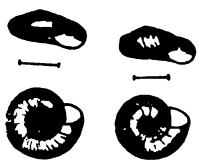

FIG. 16.—Zonitoides arboreus.

Pike's Peak, 10,000 ft., Cockerell **30**, 130. Colorado Springs, Buzzard Creek, Swift Creek and Black Lake Creek (Cockerell), Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Zonites arboreus. Hot Sulphur Springs, Blue River Valley, Howardsville, North Park and LaPlata, Ingersoll **35**, 392. South Park and Twin Lakes, Yarrow **68**, 933. Williams Canyon, Sampson **46**, 102. Wet Mt. Valley and subfossil at Grape Creek, Cockerell Mss.

Hyalina arborea. Near West Cliff, Micawber Mine, Wales Canyon, Slate Creek, Buzzard Creek, Black Lake Creek, Chalk Creek, Divide Creek, Plateau Creek, Kremmling, near Egeria and Manitou, Cockerell **22**, 62, 175; **14**, 100, 101.

H. arborea form *viridula* Ckll. Horseshoe Bend Gulch, Cockerell **14**, 101.

One of the common species along the foothills from Boulder to Lyons, extending up into the mountains, where it was found in some numbers by Mr. D. M. Andrews at Magnolia. Specimens received from Prof. E. A. Kenyon were collected at Florence; some from S. R. Rohwer were collected at Florissant, and one from Prof. Bethel was collected at Granby. We have found it fossil at mouth of Bear Canyon, about 3 miles south of Boulder. The original of the right-hand figure is designated *Z. viridulus*.

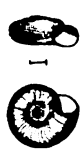

FIG. 17.—Zonitoides minusculus.

Zonitoides minusculus Binn. Fig. 17.

Trinidad (Pilsbry), Vanatta Mss.

Zonites minusculus. Ft. Garland, Yarrow **68**, 934.

We have found it fossil at mouth of Bear Canyon, three miles south of Boulder.

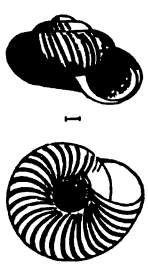

FIG. 18.—Zonitoides conspectus.

Zonitoides conspectus Bland. Fig. 18.

Zonites conspectus. Cunningham Gulch, Ingersoll **35**, 393; Binney **6**, 86, 87.

P. conspecta. San Juan County, Cockerell **14**, 103.

All Colorado records are apparently based upon Ingersoll's specimens.

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Genus **AGRIOLIMAX** Morch.

Agriolimax campestris Binn. Fig. 19.

FIG. 19.—Agriolimax campestris.

Northrop, Wet Mt. Valley, Straight Creek, West Ten Mile Creek, Blue River, Naomi, Little Blue Creek and Saguache Creek, Cockerell Mss.

This is our only native species of naked snails or so-called slugs, though there are several varieties or named forms, referred to under the subspecies *montanus*. The records are inserted as we find them, without offering any conclusions as to the wisdom of recognizing the various names. Our own specimens collected at Boulder were identified by Dr. Pilsbry as *campestris*.

Agriolimax campestris montanus Ing.

COLOR FORMS: *Typicus* (typical *montanus*), pale brown, foot-sole pale; *intermedius*, dark brown, foot-sole gray; *tristis*, very dark brown or brown black. Cockerell 15, 358, 359.

Limax montanus. Grand County, Hot Sulphur Springs, Ingersoll 35, 389, 394. Colorado, Dall 34, 366.

Agriolimax montanus. Pueblo and Saguache Counties, Cockerell 22, 62, 63.

Form *typicus*. Swift Creek, Saguache Creek, near Dillon, Naomi, Two Elk Creek, Buzzard Creek and Little Blue Creek, Cockerell 15, 359, 360. Custer, Chaffee, Saguache, Fremont, Summit, Eagle, Mesa and Gunnison Counties, Cockerell 14, 100. Canyon City, Cockerell Mss.

Form *intermedius*. Saguache Creek above Rock Cliff, Surface Creek, West Ten Mile Creek, Wheeler, Black Lake Creek and East Fork Clear Water Creek, Cockerell 15, 359, 360. Saguache, Fremont, Pueblo, Custer, Summit, Mesa and Delta Counties, Cockerell 14, 100. Canyon City, Grand Mesa, Wales Canyon, Surface Creek and Short Creek, Cockerell Mss.

Form *tristis*. East Fork Arkansas River in Lake County, Wheeler, West Ten Mile Creek, near Dillon and Surface Creek, Cockerell 15, 359, 360. Lake, Summit and Delta Counties, Cockerell 14, 100. Ward, Cockerell Mss.

Agriolimax laevis campestris, var. *montanus, castaneus, intermedius* and *tristis*, Colorado localities, Taylor 62, 134, 135. (*Castaneus* is a synonym of *montanus*.)

Agriolimax agrestis Linn. Fig. 20.

Forms *rufescens, brunneus* and *semirufus*, Boulder, Cockerell 30*b*, 90; Taylor 63, 278, 279.

FIG. 20.—Agriolimax agrestis.

One specimen liberated at West Cliff, Cockerell 14, 100.

This species was doubtless accidentally introduced, being a European species which has obtained a foothold in the eastern states. They were first found near the University campus at Boulder by Mr. L. C. Bragg, since which time we have found them in several places in the city.

Genus **PYRAMIDULA** Fitzinger

Pyramidula cronkhitei anthonyi Pils.

North Park (Barber), Ouray (Bland), Swift Creek, Black Lake Creek, Buzzard Creek, Divide Creek and Colorado Springs (Cockerell), Vanatta Mss.

Patula cronkhitei Newc. Hot Springs, Blue River Valley and Rio LaPlata, Ingersoll 35, 397. This probably should be referred to the next species.

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Patula striatella Anth. Estes Park, Binney **5**, 623. Hot Springs, Saguache, Clear Creek, North Park and Estes Park, Ingersoll **35**, 397. Empire, Ingersoll, **37**, 131. Twin Lakes, South Park and mountains near Ft. Garland, Yarrow **68**, 931.

Pyramidula striatella. Wet Mt. Valley, Black Lake Creek, Plateau Creek, Rio LaPlata, Crested Butte and White Earth, Cockerell Mss.

We have found it living at Boulder and fossil at Bear Canyon, south of Boulder, have received one specimen collected by Mr. A. Dakan at head of Muddy Creek, in Grand County, others collected at Lake George by S. R. Rohwer, and one collected at Granby by Prof. Bethel.

Pyramidula shimeki cockerelli Pils.

Custer and Saguache Counties, Pilsbry **40**, 85. Rio LaPlata, Cockerell Mss.

Prof. Shimek considers this a synonym of *P. shimeki*. To his paper Pilsbry has made no reply, thus apparently acquiescing therein, but the last specimens placed by him in the collections of the Philadelphia Academy are labeled *P. shimeki cockerelli*. We have found this species abundant at Eldora, altitude 9,300 feet, more strongly striate than specimens from Beulah, N. Mex., and less so than *anthonyi*. Immature specimens of the two species are difficult to distinguish.

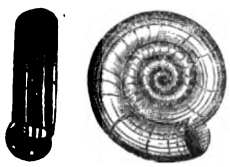

FIG. 21.—Helicodiscus parallelus.

Genus **HELICODISCUS** Morse

Helicodiscus parallelus Say. Fig. 21.

Helix lineatus Say. Animas Valley, Ingersoll **35**, 398.

Possibly this refers to the following species, since described.

Helicodiscus eigenmanni Pils.

Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Prof. Cockerell has presented the University Museum with one specimen from river drift at Trinidad.

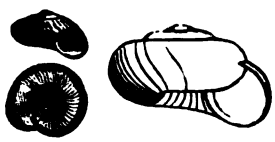

FIG. 22.—Punctum pygmæum.

Genus **PUNCTUM** Morse

Punctum pygmæum Drap. Fig. 22.

P. pygmæa minutissima Lea. Willow Creek, Cockerell **14**, 102.

Genus **SPHYRADIUM** Agassiz

Sphyradium edentulum Drap.

Colorado, Dall **34**, 367; Pilsbry & Johnson **43**, 33. Howardsville (E. Ingersoll), Estes Park (Rev. E. H. Ashmun), Vanatta Mss.

Sphyradium alticola Ing. Colorado, Dall **34**, 367.

Pupilla alticola Ing. Cunningham Gulch and Rio LaPlata, Ingersoll **35**, 391. Either Empire, Colo., or in Utah, Ingersoll **37**, 131. Mam Mts., Cockerell Mss.

Pupa alticola Ing. Western Custer County, Cockerell **22**, 62.

Pupa simplex Say. Colorado, identical with *edentulum*, inhabiting both Europe and America, Sterki **53**, 377.

Vertigo simplex Say. Twin Lakes and South Park, Yarrow **68**, 928.

One specimen was recently found by the writer at Eldora and one or two by Prof. Cockerell at Lake George.

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Genus **SUCCINEA** Draparnaud

FIG. 23.—Succinea salleana.

Succinea salleana Pfr. Fig. 23.

A few collected at Florence by Prof. E. A. Kenyon were identified by Dr. Bartsch as of this species.

FIG. 24.—Succinea sillimani.

Succinea sillimani Bland. Fig. 24.

Denver, Cockerell **25**, 29, 30.

FIG. 25.—Succinea retusa.

Succinea retusa Lea. Fig. 25.

Succinea ovalis Gld. (not Say). Mouth of Blue River, Ingersoll **35**, 399.

Succinea pfeifferi Rossm. West Cliff, Cockerell **22**, 63.

FIG. 26.—Succinea nuttalliana.

Succinea nuttalliana Lea. Fig. 26.

Hot Sulphur Springs and Animas Valley, Ingersoll **35**, 399. Subfossil at Grape Creek. Cockerell Mss.

A few have been received from Prof. E. A. Kenyon, collected at Florence.

FIG. 27.—Succinea haydeni.

Succinea haydeni W. G. B. Fig. 27.

A few received from Prof. A. E. Beardsley of the State Normal School were collected at Greeley.

FIG. 28.—Succinea grosvenori.

Succinea grosvenori Lea. Fig. 28.

Colorado, Pilsbry & Ferriss **45**, 161; Pilsbry & Johnson **43**, 34. Greeley (L. C. Wooster), Vanatta Mss.

Succinea lineata Say. Estes Park, Binney **5**, 623. Twenty miles west of Saguache, Animas Valley, bank of Bear river and San Luis lakes, Ingersoll **35**, 400. Empire, Ingersoll **37**, 132. Kremmling, Cockerell **26**, 45. Greeley, Cockerell Mss. (Ingersoll's specimens said to be mostly *avara*, Cockerell **22**, 64.)

Succinea lineata form *elongata* Ckll. Type locality Kremmling, Cockerell **24**, 39; **26**, 45.

Succinea mooresiana Lea. Round Mt., Cockerell **26**, 44.

Prof. E. Bethel has sent us a few found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte near Denver.

FIG. 29.—Succinea avara.

Succinea avara Say. Fig. 29.

South Park, Fairplay, Twin Lakes and Loma, up to 10,000 ft., Yarrow **68**, 935. Custer, Saguache and Pueblo Counties, Cockerell **22**, 63, 64. Custer County and near Cattle Creek (Cockerell), Greeley (L. C. Wooster), Gunnison County (B. H. Smith), Vanatta, Mss.

Succinea avara compacta Ckll. Type locality Chalk Creek, Cockerell **24**, 39; **26**, 44.

Form *alba* Ckll. Horseshoe Bend Gulch, Cockerell **26**, 43.

Succinea avara vermeta Say. Subfossil at Grape Creek, Cockerell Mss.

A short, globose form at Denver, Cockerell Mss.

We found it living at Boulder, fossil at Bear Canyon and dead at Manzanola, and have received dead shells from Magnolia, collected by Mr. D. M. Andrews; from Granby,

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collected by Prof. Bethel; from Florissant, collected by S. R. Rohwer, and alcoholic specimens from Monon, collected by E. R. Warren. Some specimens from Davidson's ranch have a decidedly reddish tinge.

Fig. 30.—Succinea rusticana.

Succinea rusticana Gld. Fig. 30.
Hot Sulphur Springs, Ingersoll **35**, 399.

Fig. 31.—Succinea stretchiana.

Succinea stretchiana Bland. Fig. 31.
Large specimens, Pagosa, Yarrow **68**, 936.
Form *major* Anc. Mss. Pagosa, Cockerell **25**, 31.
Specimens "doubtfully referred to *S. stretchiana* Bland," Chaffee County, Cockerell **22**, 63; but see **26**, 46.

Genus **LYMNÆA** Lamarck

Lymnæa stagnalis appressa Say.
Limnæa stagnalis Lin. Between Animas and LaPlata, Ingersoll **35**, 405. Rio Grande, Loma and Del Norte, Yarrow **68**, 941, 942.

Fig. 32.—Lymnæa parva.

Lymnæa parva Lea. Fig. 32.
Howardsville (Ingersoll), South Park (Wolf), Swift Creek, Custer County (Walker), Baker Mss.

Fig. 33.—Lymnæa humilis.

Lymnæa humilis Say. Fig. 33.
Denver and South Park, Yarrow **68**, 945. San Luis Valley and Howardsville, Ingersoll **35**, 406. Denver, Surface Creek and subfossil at West Cliff, Cockerell Mss.
Limnæa truncatula. West Cliff, Cockerell **14**, 9. Abundant in Custer County, Cockerell **22**, 63.
A specimen collected by Prof. Cockerell at Lake George we refer to this species.

Fig. 34.—Lymnæa obrussa.

Lymnæa obrussa Say. Fig. 34.
Trinidad (Ashmun), Greeley (Shimek), Baker Mss.
Limnæa desidiosa Say. Hot Sulphur Springs and Blue River Valley, Ingersoll **35**, 406. Trout Creek, Yarrow **68**, 944. Greeley, Cockerell Mss.
Abundant in overflow ditches at Boulder, associated with *L. caperata.* A few were collected at Florence by Prof. E. A. Kenyon.

Fig. 35.—L. obrussa modicella.

Lymnæa obrussa modicella Say. Fig. 35.
Limnæa modicella Lea. Collected in Lodge Pole Creek by Chas. T. Simpson, Cockerell **22**, 61.

Fig. 36.—Lymnæa bulimoides.

Lymnæa bulimoides Lea. Fig. 36.
Variety at Denver, Ingersoll **37**, 132. Probably refers to one of the subspecies following.

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Lymnæa bulimoides cockerelli Pils. & Fer.

Pool southeast of Denver, Pilsbry & Ferriss **45**, 162.

Lymnæa bulimoides techella Hald.

A few specimens were collected at Florence by Prof. E. A. Kenyon.

FIG. 37. — Lymnæa palustris.

Lymnæa palustris Müll. Fig. 37.

Between Animas and LaPlata, Ingersoll **35**, 406. Georgetown, South Park, Twin Lakes, Saguache and Loma, Yarrow **68**, 942, 943.

Decollated form, pond near Black Lake, Cockerell Mss.

Limnæa nuttalliana Lea. Between Animas and LaPlata Rivers, Ingersoll **35**, 406.

This variable species has been described under several different names. There are slight differences in specimens from different lakes, which would afford an interesting study. We have found none in the streams of this region, but have found it common in lakes of both plains and mountains up to 8,500 feet in Boulder, Weld, and Larimer Counties. It has also been collected by Mr. D. M. Andrews at Magnolia and by Prof. F. H. Hopkins at Meeker, and specimens sent by Prof. E. Bethel are believed to have been collected by Dr. T. W. Stanton at Del Norte. Prof. Cockerell mentions (Mss.) some forms from Greeley resembling forms described from Europe. Specimens from a lake near Ward were called *L. palustris haydeni* by Dr. Pilsbry and "a pathologic form of *palustris*" by Mr. Baker, who considers *haydeni* probably a synonym.

Lymnæa palustris elodes Say.

Chalk Creek, Chaffee County (Cockerell), Baker Mss.

FIG. 38.—Lymnæa sumassi.

Lymnæa sumassi Baird. Fig. 38.

Between Animas and LaPlata, Ingersoll **35**, 405.

We found specimens in some numbers at the head of Lake George and in the pool just below the outlet, which Mr Baker refers to this species, but none anywhere else in the lake. The writer feels much inclined to call them *palustris*, as does Mr. Walker also, in the absence of an opportunity to compare them with the types of *sumassi*.

Lymnæa lesi Baker.

Between Animas and LaPlata, Frank C. Baker, "Description of new species of Lymnaea," The Nautilus, Vol. XX, March, 1907, p. 125-127. In Mr. Baker's paper, received since our bibliography accompanying the first part of this paper was printed and consequently not appearing therein, he says: "Easily recognized by its short spire, very large aperture and heavy columellar plait. . . . . It has probably been heretofore identified as a form of the protean species *palustris*, but it is unquestionably distinct from any form of that species."

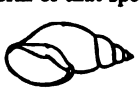

FIG. 39.—Lymnæa caperata.

Lymnæa caperata Say. Fig. 39.

Its habitat in this region appears to be overflow ditches and sloughs which are dry during part of the year. We have collected it from Boulder to Loveland and have received specimens collected by Prof. E. Bethel at Granby, by Prof. E. A. Kenyon at Florence, by Mr. S. R. Rohwer at Florissant, by Mr. H. W. Clatworthy at Ft. Morgan, by Miss

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Voight at Canyon City, and two found by Mr. A. Dakan in a spring near Boulder Falls, in the mountains west of Boulder. In view of the abundance of the species at Boulder and its wide distribution it is surprising to find a dearth of records for the state.

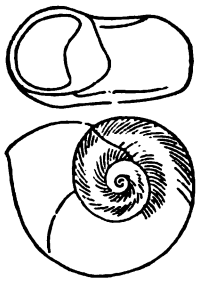

Fig. 40.—Planorbis trivolvis.

Genus **PLANORBIS** Guettard

Planorbis trivolvis Say. Fig. 40

Saguache, Yarrow **68**, 946.

Helisoma trivolvis. Between Animas and LaPlata and at San Luis Lakes. Ingersoll **35**, 404.

One of the most abundant mollusks in lakes, ponds and some small, sluggish streams from Boulder northward to Crow Creek, dead shells sometimes thickly covering the beaches of old irrigation reservoirs, usually associated with *Physa* sp. and *Planorbis parvus*. We also found great numbers in a mountain lake in Estes Park. Specimens received from Prof. E. A. Kenyon were collected at Florence, and some from Prof. Cockerell were collected at Lake George.

Planorbis trivolis plexata Ing.

St. Mary's Lake, type locality, Ingersoll **35**, 389, 402.

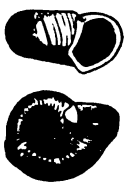

Fig. 41.—Planorbis bicarinatus.

Planorbis bicarinatus Say. Fig. 41.

Lodge Pole Creek, collected by Mr. C. T. Simpson, Cockerell **22**, 61.

We have found a few in Owen's Lake, in a sluggish stream east of Boulder and in northern Weld County, and noted a few in the collections of the State Normal School at Greeley.

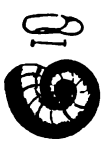

Fig. 42.—Planorbis parvus.

Planorbis parvus Say. Fig. 42.

South Park, Yarrow **68**, 947. Subfossil at Grape Creek, Cockerell Mss. Empire (Pilsbry), Buzzard Creek (Cockerell), North Park (E. A. Barber), South Park (Smithsonian), Trinidad (Pilsbry), Vanatta Mss.

Gyraulus parvus. Hot Sulphur Springs, Arkansas River, 10 miles below Granite, between Rio Animas and LaPlata, St. Mary's Lake and North Park, Ingersoll **35**, 404. Davidson's Ranch, Ingersoll **37**, 133.

Abundant on vegetation, rocks, sticks, etc., from Boulder to Crow Creek, extending into the mountains up to at least 9,000 feet. Specimens received from Prof. E. A. Kenyon were collected at Florence. We have received two specimens from Prof. E. Bethel, found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte River near Denver.

Planorbis umbilicatellus Ckll.

Davidson's ranch, Vanatta **65**, 117.

A day spent in searching for this species at Davidson's ranch resulted in great numbers of *parvus*, but not a single *umbilicatellus*. As it is not a case of mistaken identity, has the species disappeared from there?

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Fig. 43.—Planorbis exacuous.

Planorbis exacuous Say. Fig. 43.

A few specimens were found by Mr. D. M. Andrews in a small lake between Magnolia and Rollinsville, in the mountains west of Boulder.

Genus **ANCYLUS** Geoffroy

Ancylus fragilis Tryon.

On boulders in Buzzard Creek, Cockerell **22**, 65.

Fig. 44.—Ancylus parallelus.

Ancylus parallelus Hald. Fig. 44.

North Park, Ingersoll **35**, 405.

Fig. 45.—Ancylus caurinus.

Ancylus caurinus Cooper. Fig. 45.

Collected by Prof. D. W. Spangler in the St. Vrain at Longmont and by the writer in the Big Thompson at Loveland, identified by Dr. Bartsch. One specimen was collected at Ft. Collins by Mr. L. C. Bragg, in February, 1907, and sent to us for identification. This species may be considered *fragilis*, however, as some conchologists consider the two nominal species the same.

Genus **PHYSA** Draparnaud

The Genus *Physa* is in a very unsatisfactory condition. The species are difficult to distinguish from each other, quite variable in form and otherwise, many early descriptions indefinite and early records doubtful. Our experience has been that in submitting collections of *Physa* to different conchologists they will always differ in their identifications of many of the specimens, and all would like to see some genius with sufficient time, material, energy and courage monograph the genus, examining the types so far as possible. The records which follow are submitted with considerable hesitation, and we would not for the world urge anyone to accept them without question.

Physa heterostropha Say.

Hot Sulphur Springs, east of Saguache and between Animas and LaPlata, Ingersoll **35**, 400. Pueblo, Yarrow **68**, 938. Canyon City, Empire, Hot Sulphur Springs, Middle Park and Denver, Ingersoll **37**, 133. Rio Grande and Gunnison River, small variety at West Cliff, Cockerell **22**, 63, 64, 65.

It is quite possible that many or all of these records are erroneous. Until the genus is revised by some one with plenty of time and abundant material it is not safe to say much about the various species, and particularly is this true of the early records. We obtained specimens at Hamblin's Lake, near Hygiene, which Dr. Bartsch assigns to this species.

Physa wolfiana Lea.

Hot Sulphur Springs, described from specimens found in the hot water, but assigned by Ingersoll to *heterostropha*, Ingersoll **35**, 401.

Mr. Bryant Walker writes that he has specimens from the Hot Springs, but that whatever they are, they are not *heterostropha*. Specimens collected by the writer at

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Longmont and Loveland were assigned to this species by Dr. Bartsch, but Mr. Walker has compared them with his specimens of *wolfiana* from the type locality and does not consider them the same.

Physa cupreonitens Ckll.

Described from specimens found in a hot spring at Wellsville, Cockerell **22**, 63.

Physa gyrina Say.

Rio Grande, Yarrow **68**, 936, 937. Routt Co., Crandall **32**, 54. Included under *heterostropha* by Stearns **50**, 103.

This seems to be the common species in lakes and ditches at Boulder, Windsor, Gault, Ault and Crow Creek. We have received specimens from Prof. F. H. Hopkins, collected near Meeker, and from Prof. E. Bethel, collected at Denver.

Physa elliptica Lea.

Empire, Ingersoll **37**, 132. Gunnison County, Cockerell **22**, 65.

These records may be *P. gyrina oleacea*, but we have now no way of determining the matter. A few found at Owen's Lake were referred to this species by Dr. Bartsch, but Mr. Walker considers one of them an immature *gyrina* and the others not *elliptica*.

Physa integer Hald.

Collected by the writer from a lake at Windsor and ditches at Boulder, by Mr. H. W. Clatworthy at Ft. Morgan, and by Messrs. G. S. Dodds and Harvey Markman at Hamblin's Lake near Hygiene.

Physa anatina Lea.

Mr. Bryant Walker writes that he has specimens from the South Platte at Denver, collected by Mr. Billips.

Physa cooperi Tryon.

Animas and LaPlata, but both identity and validity of the species doubted, Ingersoll **35**, 401.

Specimens from Loveland and Owen's Lake are doubtfully assigned to this species by Dr. Bartsch.

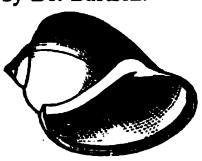

FIG. 46.—Physa lordi.

Physa lordi Baird. Fig. 46.

Specimens received from Prof. A. E. Beardsley were collected by him at the head of Rio Grande Canyon, 12 miles from Antonita, Conejos County.

FIG. 47.—Physa virgata.

Physa virgata Gld. Fig. 47.

Lodge Pole Creek, collected by Mr. Simpson, Cockerell **22**, 61.

A few specimens from near Boulder and Longmont were referred to this species by Dr. Pilsbry but Dr. Bartsch calls them *cooperi*. Mr. Ingersoll **37**, 133, mentions some specimens found by him near Denver which he thought might be of this species.

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Physa hawnii Lea.

Specimens from McCall's Lake (Dodds and Markman), Florence (Kenyon) and Canyon City (Miss Voight), are identified as *hawnii* by Dr. Bartsch, but he adds that they may be *occidentale* or even *gabbi*.

Many of the foregoing records of *Physae* may be doubted without seriously hurting the feelings of the writer or his advisers.

FIG. 48.—Aplexa hypnorum.

Genus **APLEXA** Fleming

Aplexa hypnorum Linné. Fig. 48.

Bulinus hypnorum. Grand River Valley and Bear River, Ingersoll **35**, 401.

Physa hypnorum. West Cliff, Cockerell **22**, 63. Subfossil at Grape Creek, Cockerell Mss.

Numbers were collected by Prof. A. E. Beardsley, of the State Normal School, at Greeley, and by Prof. E. Bethel, of Denver, in an overflow ditch at Granby. The latter has sent us specimens believed to have been collected by Dr. T. W. Stanton at Del Norte.

FIG. 49.—Valvata lewisi.

Genus **VALVATA** Müller

Valvata lewisi Currier. Fig. 49.

Colorado, Dall's "Land and Fresh Water Mollusks, Harriman Alaska Expedition," Vol. XIII, p. 123.

Valvata sincera Say. One specimen at San Luis Valley lakes, Ingersoll **35**, 390.

REJECTED RECORDS

Anodonta dejecta Lewis.

Arkansas River, west of 100th Meridian, Yarrow **68**, 952; Cockerell **22**, 62. This locality is believed to be certainly erroneous. See Simpson **49**, 52.

Pisidium pusillum Gmel.

Custer and Saguache Counties, Cockerell **22**, 64. This species is European, not reported from elsewhere in America, and in view of the difficulties of the genus and the unsatisfactory status of the western species, it may be safely disregarded.

Pisidium mesæ Ckll.

"A small *Pisidium*, having apparently the same relation to *P. pusillum* that *P. roseum* has to *P. nitidum*, is provisionally called *P. mesæ*. It is from the southern slope of Grand Mesa, in Delta County; it may prove to be but a variety of *P. pusillum*." Cockerell **22**, 65. Apparently described from a single specimen. The description not being sufficient to make it recognizable, as Dr. Sterki writes, especially in such a variable genus, it must for the present be considered a *nomen nudum*.

Helix nemoralis.

Two or three specimens liberated at West Cliff, Cockerell **14**, 100. They could hardly become incorporated in the fauna of the state.

Epiphragmophora coloradensis Stearns.

Erroneously credited to Colorado in Dall's list (**34**, 366), but correctly assigned to Arizona in the text at page 340.

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Zonites nitidus Müll.

Carpenter, **10**, 542. Species merely listed in a list of alpine insects. Probably a case of mistaken identity. Record included in Prof. Cockerell's list, **14**, 100.

Vertigo rowelli Newc.

"A species referred by Mr. Pilsbry to *P. rowelli* Newc.," Surface Creek, Cockerell **22**, 65. In a subsequent paper this species is listed only from California and Oregon, the Colorado record being disregarded, Pilsbry & Vanatta **44**, 610.

Vallonia costata Müll.

"West to Colorado." Pilsbry & Johnson **43**, 7. We are aware of no records which may be considered safe. See *V. cyclophorella*.

Lymnæa aff. **rowelli** Tryon.

Rio Grande County, Cockerell **22**, 64. Identity uncertain and cannot now be determined.

Lymnæa ferruginea Hald.

Between Animas and LaPlata, Ingersoll **35**, 406. Recorded with doubt as to identity.

Lymnæa traski Tryon.

Colorado, no definite locality, Ingersoll **35**, 406. A Pacific Coast species. We suspect a mixing of labels or mistaking abbreviation of California for Colorado.

Pleurocera sp.

"Among mollusks Pleurocera and Pisidium were observed in the Pike's Peak lakes." Ward **67**, 143. Probably refers to some species of *Lymnæa*.

Somatogyrus subglobosus Say.

Five specimens from San Luis Valley lakes, Ingersoll **35**, 390. We dare suspect that these were very depressed *Lymnæa bulimoides cockerelli*.

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THE SILVA OF COLORADO

II. The Poplars, Aspens and Cottonwoods

By Francis Ramaley

Occurrence and distribution.—The genus *Populus*, which includes the poplars, aspens and cottonwoods, is represented in Colorado by six well-known species. As a rule, these trees grow along river bottoms and in moist canyons but the quaking aspen forms groves on hill- and mountain-sides at various altitudes. Even this species is found only in rather damp soil, and it is often remarked that a given hillside must be moist because there are quaking aspens growing on it. In the plains region it is possible to locate the courses of streams for long distances by the "cottonwoods" which grow along the banks. In Colorado, with its thousands of acres of needle forest, there are few places with forest cover of broad-leaf trees. Such forest areas as do exist are generally small. In the mountains the trees are aspens, and in the plains region they are "cottonwoods." The geographical distribution of the different species of cottonwood is not well known because most people do not distinguish them easily and there has not been a thorough and systematic study of these trees by competent botanists except in a few parts of the state.

Economic value.[1]—In Colorado, up to the present time, the wood of species of *Populus* has been used for fuel and somewhat in the building of fences and sheds. The trees are not very abundant and the supply of such wood soon becomes exhausted. However, there are tracts of bottom-land in the plains region well adapted to the growth of these trees. It may be expected that in time farmers and ranchmen will find that a wood-lot is an important part of a farm and they will grow trees just as now they grow grains and fruit. When more valuable trees such as black locust and hardy catalpa are planted the farmer may well reserve a part of his wood-lot for the rapid-growing native poplars.

[1] For remarks on the economic value of forests in general, and particularly for Colorado, see the author's previous paper in this series—*University of Colorado Studies*, Vol. IV, No. 2, p. 109.

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In the eastern and northern United States poplar is used in large amount for the manufacture of paper pulp. The wood-pulp industry may at some time become important in Colorado where pine and spruce can be obtained; mills will then be able to use aspen as well. At various points on the north slopes of mountains in southern and western Colorado there are groves of aspen on land of little use for growing anything else. Since many of these groves are in the national forest reserves, it is to be expected that the aspen will be used for pulp or for other purposes. In view of the increasing scarcity of wood it may be that aspen will be sawed up for crates and boxes, especially light cases such as are used for eggs and fruit.

Poplars and cottonwoods as shade trees.—Nearly all of our native species have been tried as shade trees in the towns and cities of Colorado. However, the common western cottonwood, the balm-of-Gilead and the lanceleaf cottonwood are the most satisfactory. They are well adapted for planting. They are handsome in form; the foliage, especially of the first named, is a brilliant shining green; they grow rapidly and easily endure extremes of moisture and drouth unless these are greatly prolonged. A serious objection to all the poplars is their short life. In thirty or forty years they reach full maturity and begin to die. Hence, when planted for quick results, other more slow-growing and longer-lived trees should be set out at the same time. Sometimes the "cotton" of these trees is so abundant as to cause much annoyance to housewives. However, if only stamen-bearing trees are planted, or else if the cotton-bearers are cut down, there can be no objection raised on this score.

The "Carolina poplar," much planted in recent years, has the same good qualities and the same shortcomings as our native species. The Lombardy poplar, well known to everybody because of its tall, spire-like form, is frequently planted and so also is the silverleaf poplar. The latter is certainly desirable as an ornamental tree.

Autumnal colors.—In the Rocky Mountains there are few trees which show handsome autumnal colors. There are no hard maples and gum trees to turn various shades of orange and red. Hence the colors of the poplars become interesting. The foliage of most of these trees turns yellow and brown in autumn. The common western cottonwood is one

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of the earliest trees to turn color. As a rule, the leaves of certain large branches become quite yellow while those on other limbs are still green. Later the color becomes general. In mountain districts the quaking aspen becomes a conspicuous feature of the landscape because of the bright yellow of the ripened leaves. Sometimes a single grove will show an orange or pale-red tint. Such an occurrence is by no means common, but when this color is developed a very striking appearance is produced.

Different species of Populus in Colorado.—The species are, for the most part, easily distinguished. However, it sometimes happens that there are puzzling variations. It is also probable that natural hybrids occur and these may not be recognized as such. Anyone wishing to become familiar with the different species should first make sure of the typical specimens in the locality and not until later attempt to determine the occasional abnormal forms. Since some trees are found only in the foothills, some in the plains region and some under cultivation, it follows that one need not look through all the descriptions given below for the particular tree which he is examining. Thus the determination of a species by means of the key and descriptions becomes simplified. It must be remembered that specimens of any of the native species may be found planted as shade trees, but the introduced species are not found except under cultivation. In attempting to distinguish the various species the chief difficulty is to tell the western cottonwood[1] from the cottonwood of the Mississippi Valley.[2] This latter tree is frequently planted for shade. The narrowleaf cottonwood[3] and the lanceleaf cottonwood[4] are also easily confused unless careful attention be given to all the points of the description. The balm-of-Gilead,[5] although belonging to the group with round leaf-stalks, resembles, in form of leaf-blade, the species with flattened stalks, such as the common western cottonwood and the Carolina poplar.

Botanical characters.—The genus *Populus* is one of the two genera of the Willow Family. Salix, the other genus, includes the willows. As a rule there is no difficulty in telling a poplar from a willow. Poplars generally have broad leaves and willows have narrow leaves. But the

[1] *Populus sargentii*=*P. occidentalis.*
[2] *Populus deltoides.*
[3] *Populus angustifolia.*
[4] *Populus acuminata.*
[5] *Populus balsamifera.*

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narrowleaf cottonwood has a leaf as narrow as is found in some species of willow. A glance at the medium-sized branches will show, however, a whitish-gray bark in the poplar and a dark gray in the willow. Both the willows and poplars have the flowers in catkins. The pollen-bearing and seed-bearing catkins are borne on different trees. Those of the willows are erect and those of poplars hang down. Both willows and poplars produce "cotton," but this is more abundant with some species than others. The "cotton" is made up of hairs surrounding the seeds. Since the seed-bearing trees occur in about the same number as the pollen-bearing trees it happens that, in nature, one-half of the trees are cotton-bearers. About twenty-five species of *Populus* are known to science; all belong to the northern hemisphere, but a few species extend well south into Mexico, central Asia and northern Africa. Northward the range is to the Arctic Circle.

Poplars in Colorado during former geologic times.—It is evident from the present wide geographical distribution of the poplars that they are an old group of plants. This is also well shown by the fossil leaves of these trees found in various parts of the world. In Colorado specimens of fossil poplars have been found at Florissant and at Golden. There were at least five species of poplars growing at Florissant during Tertiary times.[1] The fossil remains are very perfect as to the leaves and we can tell the shape, size and veining. Unfortunately nothing is known about the height of the trees and their general habit of growth. However, we may suppose that they looked very much like our cottonwoods of today. Some of the leaves were large, as much as 14 cm. (5½ in.) broad. Other trees had long and narrow leaves, like those of our present-day narrowleaf cottonwood. One species was much like the quaking aspen in the form and size of leaf. It is interesting to know that these poplars of a bygone day are so similar to living species. The climate of Florissant is cooler than it used to be. In those days the poplars grew along with such plants as holly and live oak and persimmon, for fossil remains of these trees occur also at Florissant. At the present time the poplars of Florissant grow with willows, birches, pines and spruces. In fact the species of *Populus* are now nearly all

[1] According to Professor T. D. A. Cockerell, who has kindly placed his notes at my disposal.

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confined to the cooler and temperate regions of the world. Only a few occur in the warmer parts. Fossil remains at Golden, Colo., show that five or six species of poplar grew there at a still earlier time than those at Florissant. Thus we may be sure that for thousands and perhaps millions of years the cottonwoods and poplars have been among the more conspicuous trees of this part of the world.

Genus POPULUS

Trees with alternate, undivided leaves, lanceolate to broadly triangular or heart-shaped; the buds with resinous, aromatic scales. Flowers in aments (catkins) without floral leaves. Staminate and carpellate aments on different trees; the aments made up of bracts, each bearing a single flower in its axil; staminate flowers with 8 to 30, or more, stamens; carpellate flowers with 1 pistil, bearing 2 to 4 elongated styles. Fruit a 2- to 4-valved capsule. Seeds small, provided with long, densely matted, silky hairs, the "cotton."

Key to Species of the Genus Populus[1]

A. Leaves white-hairy underneath, more or less lobed. (Cultivated from Europe.) 1. **Populus alba**

B. Leaves smooth, not white-hairy, at least when full grown.
  a. Trees tall, spire-shaped, the branches extending upward close to the trunk. (Cultivated from Europe.) 2. **Populus nigra italica**
  b. Trees not spire-shaped; branches variously placed.
    a. Leaf-stalk much flattened laterally where attached to blade of leaf. Leaves easily rustled by the wind; blades broad.
      a. Leaf-blades somewhat circular in outline with short-pointed apex. Bark very white. Tree of foothills and mountains. The "quaking aspen." 3. **Populus tremuloides**
      b. Leaves rather broadly triangular or somewhat heart-shaped. Native cottonwoods; but often planted for shade.
        a′. Teeth of the leaf-blades less than 10 on each side. Tree of southern Colorado and southward. 4. **Populus wislizeni**
        b′. Teeth of the leaf-blades more than 10 on each side.
          aa. Leaf-blades very broad, often broader than long; toothed all around except at base; tip of blade narrow-pointed. (Our common western cottonwood.) 5. **Populus sargentii**
          bb. Leaf-blade generally not as broad as long; toothed all around. Young twigs angular, due to development of cork in ridges. (Cultivated from central U. S.) 6. **Populus deltoides**
    b. Leaf-stalk nearly cylindrical or slightly flattened.
      a. Leaf-blades ovate, abruptly angled at apex; rounded or cordate at base; under surface whitish. 7. **Populus balsamifera**
      b. Leaf-blades lanceolate or ovate, generally narrowed at base.
        a′. Leaf-blades rather narrow; often abruptly pointed. Leaf-stalk one-third as long as the blade, or less. 8. **Populus angustifolia**
        b′. Leaf-blades broader than in the preceding species; ovate or somewhat triangular; mostly long-pointed. Leaf-stalks slender, generally more than half the length of the blade. 9. **Populus acuminata**

[1] This key includes the native Colorado poplars and three other species frequently planted for shade.

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Technical descriptions.—The following descriptions of the different species of aspen and cottonwoods give not only the technical characters but also certain information in regard to appearance, habit, wood-structure and uses. Citations are made to the more accessible books of reference, as in the writer's article on the Pine Family published in the preceding number of these *Studies*. The reader is referred to that article for a fuller list of works dealing with the trees of Colorado. In the key and description of species no mention is made of flowers and fruit. These characters are fully described in the books cited. The text figures, except Fig. 2, are all original, from specimens in the University herbarium. Fig. 2 is copied from Sargent's *Trees of North America*. Attention is called to Fig. 1, which shows the true shape of the leaves much better than the figures given by Sargent or by Britton and Brown.

1. **Populus alba** Linn. WHITE POPLAR, SILVERLEAF POPLAR

Leaves broadly ovate in outline, variously toothed, sometimes deeply cleft and resembling in shape those of the soft maple. Young foliage densely white-hairy, the lower surface persistently wooly. Leaf-stalks nearly cylindrical, considerably shorter than the blades.

A medium-sized tree with smooth, light-gray bark and spreading branches. Wood soft, nearly white, somewhat heavier than that of most of the poplars. Numerous varieties of this species are known in cultivation. The roots extend horizontally a short distance below the soil and send up numerous suckers by which propagation is effected.

Native of Europe and Asia. Naturalized by cultivation in the New England and Middle Atlantic States. Planted as a shade and ornamental tree in the towns and cities of Colorado. The trees are usually bent in the direction of the prevailing winds. In Colorado and elsewhere the variety with sharply lobed leaves is often wrongly called "silverleaf maple."

2. **Populus nigra italica** DuRoi. LOMBARDY POPLAR

Leaf-blades rhombic or deltoid, wider than long, crenulate all around; smooth from the first; leaf-stalks equaling the blades in length.

A tall, narrow, spire-like tree with prominent main trunk; the branches ascending and very numerous; bark thick and furrowed. This is a horticultural variety of the black poplar of Europe.

Known only in cultivation. Formerly much planted throughout the United States but now less common. The trees do well in Colorado but may be expected to die at the top as they grow old.

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3. **Populus tremuloides** Michx. ASPEN, QUAKING ASP

RYDBERG, *Flora Colo.* 91; COULTER, *Manual* 339; SARGENT, *Manual Trees of N. A.* 154; NELSON, *Key to Rocky Mountain Flora* 15.

Leaf-blades broadly ovate, often nearly circular in outline, short-acuminate at the apex, finely crenulate all around except at the base, 2 to 4 cm. (¾ to 1½ in.) broad, except those at the ends of twigs which are much larger; dark green above, grayish green below. Leaf-stalks about the same length as the blades; slender and laterally compressed.

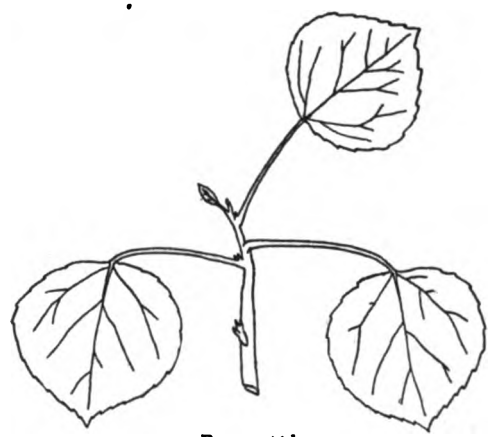

FIG. 1. ×½

A small or medium-sized tree, bearing slender, remote, crooked, horizontal branches. Bark thin, rather smooth, or with wart-like excrescences, white or yellowish green; near the base of old trees the bark is thick, ridged and almost black.

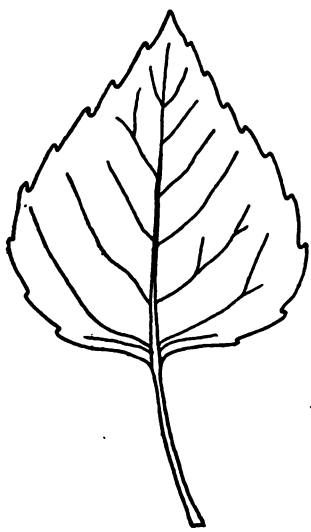

FIG. 2. ×½

Heart-wood yellowish brown; sap-wood nearly white; specific gravity 0.4032. Wood soft, light, close grained, consisting of fibers and small ducts; on account of its structure admirably adapted for the manufacture of wood pulp. Thus far no pulp mills have been established in Colorado to use this wood.

Widely distributed throughout the northern United States and Canada, south to Pennsylvania, Missouri, northern Nebraska, and in the mountain ranges of the West, extending to Arizona, New Mexico and northern Mexico. The light, cottony seeds easily distributed by the wind. Like the lodgepole pine it forms pure growths in places formerly covered with a mixed coniferous forest. It does not extend to the plains region. This tree is sometimes planted for shade in the mining camps of Colorado.

4. **Populus wislizeni** (Wats.) Sargent. COTTONWOOD (FIG. 2)

RYDBERG, *Flora Colo.* 91; SARGENT, *Manual Trees of N. A.* 165.

Leaf-blades broadly deltoid or ovate-orbicular, about 5 to 7 cm. (2 in. to 2¾ in.)

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broad; coarsely serrate or crenate with less than ten teeth on each side. Leaf-stalks slender, nearly as long as the blades.

A large spreading tree with stout, light-orange-colored glabrous branchlets. Wood light, soft, used for fuel; specific gravity 0.4621. Bark pale gray-brown, divided into broad, somewhat rounded ridges.

Southern Colorado, south to Texas and Arizona; the common cottonwood of the Rio Grande valley in western Texas and New Mexico. Reported by Rydberg from Arboles, Grand Junction, and Colorado Springs in this state.

5. **Populus sargentii**[1] Dode. WESTERN COTTONWOOD

RYDBERG, *Flora Colo.* 91 (as *P. occidentalis*); COULTER, *Manual* 339 (as *P. angulata*); Sargent, *Manual Trees of N. A.* 164 (as *P. deltoides*, var. *occidentalis*); NELSON, *Key to Rocky Mountain Flora* 15 (as *P. deltoides*).

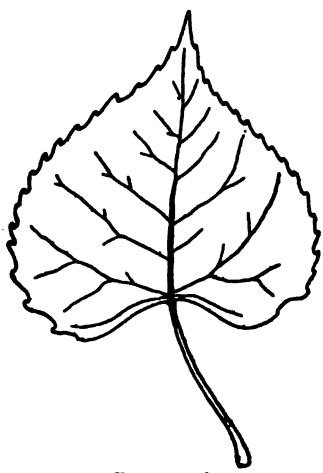

FIG. 3. × ½

Leaf-blades broadly deltoid or heart-shaped, about 8 cm. (3½ in.) broad, with narrow acuminate points; dark green and shining above, slightly paler beneath; toothed or serrate except at base with more than ten teeth on each side. Leaf-stalks laterally compressed in the upper part, somewhat shorter than the blades.

A large or medium-sized tree, the trunk generally divided about 5 meters above the ground into several massive limbs which spread rather widely and give rise to a wide, open crown. Bark of young trees thin, becoming on old trees thick and deeply divided into broad, rounded ridges; that of younger trunks and branches cream-gray or tan color, but dark gray in old trees. Wood light, soft, not strong, close grained; heart-wood brownish, sap-wood nearly white. Used for fuel and in building fences and sheds. Could be used for pulp manufacture.

Rocky mountain region from Canada to Arizona and east to Kansas and Nebraska. This species grows on river bottoms of the plains region and in canyon mouths but not at high altitudes. According to Rydberg's *Flora* it ranges (in Colorado) from 4,000 to 7,000 feet but he reports a specimen collected near Eldora, altitude 8,400 feet. There is very little difference between this species and *Populus*

[1] The author is under obligation to Dr. P. A. Rydberg of New York for information in regard to the name for the western cottonwood. According to Dr. Rydberg the name *occidentalis* is preoccupied by a fossil species. Professor Dode of Paris has named a number of new species from garden material. Of these species *P. sargentii* is our tree. Perhaps some of the others are mere forms of it. Since the other names appear first on the page they have priority. So if they shall prove to be our tree the name *sargentii* will have to be discarded and one of the other names used instead. These are: *P. bussyana* and *P. henryana*.

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deltoides which is found in the Mississippi Valley. In fact our tree was long considered to be merely a western form of that species.

6. **Populus deltoides** Marsh. COTTONWOOD, CAROLINA POPLAR

It is not necessary to give a full account of this species since it is much like our western cottonwood. Certain differences may be pointed out: the leaves do not have the long narrow point seen in the western cottonwood, they are longer in proportion to the width, and are more finely toothed, and the young twigs are usually ridged longitudinally with corky thickenings.

The name "Carolina poplar" applies to a form of this species which has a symmetrical shape. There is one main trunk from which the branches pass off in a somewhat ascending direction.[1]

This species ranges through the eastern United States and the Mississippi Valley.

7. **Populus balsamifera** Linn. BALM OF GILEAD

COULTER, *Manual* 339; SARGENT, *Manual Trees of N. A.* 157; (not reported in RYDBERG'S *Flora of Colorado*).

Leaf-blades ovate, serrate, dark green above, pale beneath, very distinctly veined below; abruptly pointed at the apex; rounded or cordate at base, about 6 cm. (2⅜ in.) broad, nearly cylindrical, the stalks at least half as long as the blades.

FIG. 4. × ½

A large or medium-sized tree resembling in general appearance the lanceleaf cottonwood. Winter buds large, coated with a sticky varnish. Bark gray-brown, in old trunks broken into rounded ridges.

Widely distributed in the northern part of North America. Common along the northern boundary of the United States from Maine to Minnesota; extending from Alaska to Oregon, Nevada and Colorado. In sub-arctic regions of northwest America it forms the most characteristic feature of the vegetation; in Colorado confined to canyons and draws in the higher foothills and mountains.[2] The writer has collected specimens at Eldora, Boulder County, Colo., altitude 8,400 feet. Distinguished from the lanceleaf cottonwood chiefly by the whitish under surface of the leaves and prominent reticulate venation.

[1] Mr. George B. Sudworth of the U. S. Forest Service informs me that the differences between the "Carolina poplar" and the typical *P. deltoides* disappear as the trees reach full growth.

[2] The writer is indebted to Professor E. Bethel, of Denver, for information in regard to the distribution of this species and also for a specimen collected near Georgetown.

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8. **Populus angustifolia** James. NARROWLEAF COTTONWOOD

RYDBERG, *Flora Colo.* 91; COULTER, *Manual* 339; SARGENT, *Manual Trees of N. A.* 159; NELSON, *Key to Rocky Mountain Flora* 15.

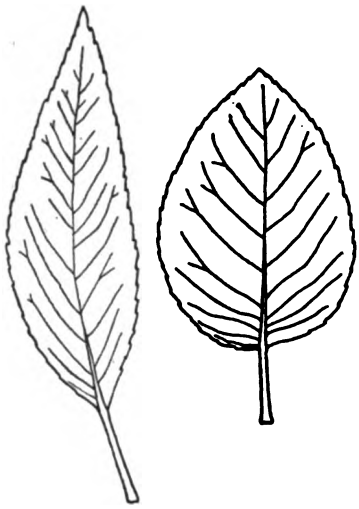

FIG. 5. ×½

Leaf-blades narrowly lanceolate, sometimes broader; varying from acute to obtuse at apex; differing greatly in shape even on the same twig (see accompanying figures); finely toothed all around; usually not more than 2 cm. (¾ in.) broad, but sometimes twice as broad. Leaf-stalks channeled above, short, generally less than one-third the length of the blade.

A rather small, spreading tree, with pale gray twigs, except the youngest, which are yellow-brown. Bark not thick, divided near the base by shallow fissures into broad flat ridges. Wood soft, compact, close grained; specific gravity 0.3912, the heart-wood brown and sap-wood nearly white. Used for fuel.

River bottoms and canyons from North Dakota to the Pacific coast and south in the mountain ranges from Canada to New Mexico. This is one of the commonest cottonwoods in northern Colorado where it is found on river banks of the plains regions and extending well up in the canyons. Distinguished from other species by the very short leaf-stalks.

9. **Populus acuminata** Rydb. LANCELEAF COTTONWOOD

RYDBERG, *Flora Colo.* 91; SARGENT, *Manual Trees of N. A.* 160; NELSON, *Key to Rocky Mountain Flora* 15.

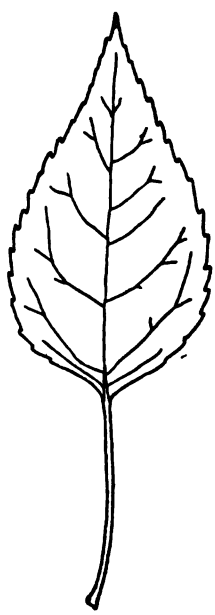

FIG. 6. ×½

Leaf-blades ovate or broadly lanceolate, variable as to shape and size, crenately serrate, averaging about 4 cm. (1⅝ in.) broad. Leaf-stalks slender, about half or two-thirds as long as the blades.

A rather small tree with compact, round-topped crown, branchlets roughened, the larger branchlets whitish or gray. Wood light, soft, of little value except for fuel.

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River bottoms and canyons from Black Hills of South Dakota to the Rocky Mountains and the great basin. Generally confused with the narrowleaf cottonwood, but distinguished by the broader leaf-blade and longer stalk. Not so common as the preceding species; the distribution is somewhat local. Sometimes planted as a shade tree.

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VOLUME IV NUMBER 4

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

JUNE, 1907

Price, 50 Cents

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THE INCREASE OF DIVORCE

By John Burton Phillips

To understand the increase of divorce it is necessary to take into consideration those forces which are said to be weakening the influence of the family. These forces have been set in motion by modern industrial and social changes, and while not perhaps tending strongly to disintegrate the family, have nevertheless considerably affected its position in the social structure.

The modern family has shared fully in the movement for freedom which has been so characteristic of the last hundred years. Today the family is a sort of free government. The children are ruled by other methods than by the rod. The absolute power of the father is gone. Each member of the family in some degree takes part in its government. The development of liberty in the family is also apparent in the legal position of the wife. Her property is now her own and marriage does not interfere with her rights to its control.

The same change appears in the recognition of the rights of children. Various laws restrict the father's control over them. The parents are compelled to send them to school, and a great movement is now under way to restrict their employment in industry till they are sixteen years of age. This legislation is an outgrowth of the idea of liberty, and the result is the limitation of the father's power in the home.

It is also probably true that modern children are less respectful toward their parents than was formerly the case. The children of American parents are said to be less respectful than those of European. Whatever truth there may be in this is perhaps due to the fact that America is a democratic country and in such a country where classes are not sharply defined children are not likely to show the respect for parents which they display in older and more settled countries where society is more nearly in a static condition. In European countries the boy is as a rule brought up to follow the vocation of his father. He does not try to get out of his class. He therefore thinks differently of the

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business his father has followed and consequently of his father than do children in the United States. Here the children are taught to learn a trade or to follow a profession superior to that of the father. The boy who from childhood is taught to think that his father's trade of bricklaying is not good enough for him, but that he is to become a physician, is not likely to think his father a great man. Every man in America urges his son to do something better than he himself has done and this is wise. It is the glory of the American national life that the children are filled with the ambition to rise higher than their fathers have risen, but it comes at the expense of that respect which is almost veneration in countries where the son does not try to rise above the level attained by his father.

Since the invention of machinery has opened to women various industrial opportunities, they have become less dependent and the age at which marriage takes place is more advanced. The effect of this is a diminution in the marriage rate of nearly all countries for which statistics are available.[1] Hence, the importance of the family has been somewhat lessened. Women prefer marriage to industry, but since they are able in industry to make a living for themselves, they use greater care in the acceptance of a husband than was the case when they were more dependent. There is some advantage in this as the result is a more wholesome family life. There is every reason to believe that the family life of today is greatly superior to any that existed at any previous time.

Another reason for the decline in the importance of the family is to be found in the fact that marriage is an economic drawback. As a rule when a bachelor marries he finds that the expense of living is multiplied about two and one-half or three fold. Rents are very high and to maintain a home is an expensive luxury. While a home is worth all it costs, it is simply beyond the reach of the young man working in the city for sixty dollars a month. Then, too, the benefits resulting from increased salary due to marriage are scarcely worth considering as but a small percentage of firms will raise the salaries of their employees when they marry. From a purely financial point of view the young

[1] BAILEY, *Modern Social Conditions*, p. 139. For statistics of marriages in Massachusetts, see *Mass. Labor Bulletin*, No. 44, p. 459 (December, 1906).

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man on small salary is worse off after marriage. If the marriage results in children, it may be that he will be unable to maintain his home in those parts of the city where he lived before marriage, for in many of the desirable sections of the great cities houses will not be rented to families with children. This is especially true of New York City.

The economic disadvantage of marriage is somewhat intensified by the current matrimonial ideal. This ideal is in part the result of the great increase of wealth in the United States during the last two or three decades. The middle class has become rich and a great multitude of women have had leisure thrust upon them. As far as the home is concerned, wealth transmutes itself into the maintenance of an establishment. Hence the idea now so prevalent that a home means a servant and leisure for the wife to devote herself to more or less elaborate social functions. This entails an additional expense upon the husband which he is not always able to bear and brings him to a fuller realization of the economic burden involved in marriage. It is not difficult for persons married and having but a small income, and desiring to realize the more ambitious matrimonial ideal to think of divorce when the family ship begins to encounter the storms of the matrimonial sea.

Some of the more conservative forces tending to maintain the coherence of the family have been considerably weakened by the social changes incident to modern progress. Public opinion which formerly frowned severely upon easy dissolution of marriage has changed very much in its attitude on this question during the last half-century. Along with the amazing development of the idea of individual liberty it has been impossible for public sentiment to recognize such a movement as the independence of woman and not at the same time sanction divorce more often than in the earlier times. Consequently, the force of public sentiment tending to hold the family together has weakened.

In former times the church had much to do with strengthening family ties, and it is still powerful in this respect though not in the same degree as in the past. The Catholic church sanctions no cause of divorce and the Protestant church but one. Though the influence of the church in this respect has weakened, it is clear that were it not for the pressure brought to bear upon them by the religious agencies, many families

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would long since have sought the divorce courts. The increase of individual liberty of thought and action, however, has made the modern world heed in lessening degree the commands of ecclesiastical authority.

Such are the principal causes that are said to be weakening family ties and leading to an increase in the number of divorces. Whatever the effects of these causes, it is clear that the number of divorces has greatly increased. This increase is not confined to any one country, but like the diminishing birth-rate is a phenomenon common to all civilized nations during the last half-century.

From 1867 to 1886, the only time in which divorce statistics for the United States have been collected, the number of divorces increased about 350 per cent. in Belgium, 200 per cent. in England, 100 per cent. in France, and 157 per cent. here. During the same period our population increased about 60 per cent.[1] It is thus apparent that divorces have increased much more rapidly than population both in this and in other countries.

NUMBER OF DIVORCED PERSONS TO EVERY 100,000 OF THE POPULATION[2]
STATISTICS FOR 1886

Ireland	.28
Italy (1885)	3.75
England and Wales	3.79
Canada	4.81
Australia, New Zealand and Tasmania	11.14
German Empire	25.77
France	32.51
Switzerland	64.49
United States	88.71
Japan	608.45

The most curious feature of this table is the variation in the divorce rate. Catholic Ireland has the lowest rate and although Protestant United States has been popularly supposed to excel in affording opportunities for the severance of the family tie, it is surpassed by non-Christian Japan. During the year 1886 there were 315,311 marriages celebrated in Japan and during the same year 117,964 divorces were granted.[3] The number of divorces exceeded one-third of the number of marriages.

[1] *Report of the Commissioner of Labor*, 1889, Marriage and Divorce, pp. 140, 998, 1007, 1017. In Massachusetts, from 1860 to 1904, population increased 140 per cent., marriages 109 per cent., and divorces 598 per cent. *Mass. Labor Bulletin* No. 44, p. 460 (December, 1906).

[2] WILLCOX, "Vital Statistics," *Pol. Science Quarterly*, Vol. VIII, p. 78 (March, 1893).

[3] *Ibid.*

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Some explanation of the high divorce rate in Japan may be found by examining the grounds for divorce in that country. The following are the causes for which the husband may obtain a divorce: (1) if the wife is disobedient to her foster-parents, (2) if barren, (3) if licentious, (4) if jealous, (5) if diseased, (6) if she steals, (7) if she talks too much.[1] It is thus apparent that any married man may have a divorce at almost any time according to the laws of Japan.

There are also great fluctuations of the divorce rate in the American states. In 1880 the number of marriages to one divorce was in Delaware 5542, North Carolina 3149, Louisiana 1630, Virginia 1743, New York 1152, Utah 219, Montana 180, Wyoming 173, Nevada 170, Colorado 136. This ratio is also higher in cities than in rural districts or the country as a whole. In the cities of Europe the rate is usually three or four times as high as for the entire country. In Hamburg and Berlin the rate is three and one-half times as great as for Germany.[2]

A higher divorce rate might be expected in the cities and the newer states of the West.[3] The restless and discontented are to be found in these localities where life is more inviting to them than in older and more settled regions. A more intense democracy is also found in the newer states and this helps to swell the divorce rate there.

It is in the newer countries that divorces are most numerous. Here society is in a dynamic condition and the liberty of the individual is most strongly emphasized. Hence the legal system allows easy divorce. Spain forbids both divorce and legal separation. Italy has legal separation but no divorce. England grants separation or divorce for the adultery of the wife, but only separation if it is the act of the husband.

[1] GRIFFIS, *The Mikado's Empire*, Vol. II, p. 557.

[2] *Report of the Commissioner of Labor*, 1889, Marriage and Divorce, pp. 148, 1020 *et seq.*

[3] The divorce rate in Japan is exceeded by the rate in certain counties of North Dakota.

		MARRIAGES TO ONE DIVORCE
Japan	1886	2.67
Cass County, N. D. (Fargo)	1895	2.76
" " " "	1896	1.91
" " " "	1897	1.89
" " " "	1898	1.71
" " " "	1899	2.36
" " " "	1905	18.39

The decline in the rate is due to the law enacted in 1899 requiring twelve month's residence before application for divorce. A still higher rate might possibly be shown for certain counties of South Dakota if figures were available. COULTER, "Marriage and Divorce in North Dakota," *American Journal of Sociology*, Vol. XII, No. 3, p. 411 (November, 1906).

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The same rule prevails in Canada. The eastern and southern states are conservative and grant few divorces. In New York adultery is the only cause. South Carolina grants no divorce. In the western states divorces are mostly granted for the three causes, desertion, cruelty and adultery. As a rule three-fourths of the divorces have been granted for these three causes.[1] One of the defects of the law is that it does not define cruelty. All sorts of definitions have been given by the courts. Failure to take wife out riding, talking late at night, snoring in one's sleep, have each been defined by the court as cruelty and a divorce granted. In the state of Washington there was a law in force in 1886 by the provisions of which the judge might grant a divorce if in his discretion it was the best thing for the parties concerned.

This elasticity in the interpretation of the meaning of the word cruelty, and certain lax laws of residence in the various western states have led to what is known as migratory or carpet-bag divorce. Persons in the eastern states desiring a divorce migrate to the West, acquire a residence, secure a decree and then return to their original state. This is one of the causes which tends to swell the number of divorces granted in the western states though it does not fully account for the high rate there. South Dakota has the most unenviable record in this respect. It had for a number of years a law which allowed a divorce to be granted after a residence in the state of only ninety days. Great numbers of New York and other eastern people migrated to this state and secured divorces. At the present time the required residence before application for divorce in South Dakota is one year.[2]

Various proposals for the reform of the divorce evil by legislation have been brought forward. Among them the best known are, perhaps, restriction of divorce, of remarriage after divorce and restriction of marriage. Few students of the question will agree that any of these proposals is practicable.

As to the restriction of divorce by law, it is generally conceded that law can do little except by making divorce expensive. In this way law

[1] In California, Indiana and Michigan great numbers of divorces are granted for non-support, but this is not a cause for divorce in all states.

[2] For a number of years the required residence in South Dakota has been six months, but in March, 1907, the present law was enacted.

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can effectually limit the number of divorces. It has been pointed out that from 1867 to 1886, 328,716 divorces were granted in the United States, while during the same period only 135 were granted in Canada. England also has a very low divorce rate. In both of these countries divorces cost several hundred dollars each. This is the principal reason why they are so few. As far as experience goes, this is about the only way in which legislation will greatly lessen the number of divorces. Few would advocate the restriction of divorce by increasing the expense of such litigation.

As to the restriction of the remarriage of divorced persons by law it may be said that this is considered an unwise measure by those students who have given most attention to the problem. At the tenth national conference of the state boards of commissioners for promoting uniformity of legislation in the United States, it was decided not to recommend the enactment of such legislation to the states. The committee entrusted with the preparation of reform divorce laws recorded its opposition to legislation restricting the remarriage of divorced persons in the following words:

> The evident intent of these statutes is to prevent the guilty party from entering into another marriage. He having been unfaithful to the obligations of the first marriage, it is presumed that he is unfit to enter into a second marriage unless he reforms. But such prohibition is in fact a restraint of marriage. It leaves at large a person who by false representations may induce an unsuspecting woman to enter into a void marriage; or if this does not occur, the unfortunate defendant who cannot marry is tempted to continue adulteries without incentive to reformation. A prohibition which restrains marriage, encourages adultery, leaves the party in a position to contract void marriages and takes away a natural incentive to reformation, should be held contrary to public policy. These considerations are sufficient to justify the repeal of such statutes.[1]

Divorces are probably not sought for the purpose of remarriage in any such degree as is popularly supposed. Statistics seem to show that divorced persons are scarcely more apt to remarry than are the widowed. There are no statistics of the remarriage of such persons in the United States but in Switzerland the data have been collected.

[1] NELSON, "Divorce and Separation," p. 566. *Report of Tenth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1900, p. 46.

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REMARRIAGE OF DIVORCED PERSONS IN SWITZERLAND[1]

Time between End of First and Beginning of Second Marriage	Of 1000 Widowers Remarrying within Ten Years, Number Remarrying Each Year	Of 1000 Such Divorced Men, Number Remarrying Each Year	Of 1000 Such Widows, Number Remarrying Each Year	Of 1000 Such Divorced Women, Number Remarrying Each Year
Less than one year	323	300	95	194
One year	260	255	264	282
Two years	136	151	152	166
Three years	82	106	132	127
Four years	48	53	91	68
Five–nine years	108	101	196	125
Ten years	43	34	70	38
Total	1000	1000	1000	1000

This table shows that in Switzerland divorced men are not more likely to remarry than widowers, while divorced women remarry during the year in which the divorce was granted at a rate about twice as great as that of the widows during their first year of widowhood. In explanation of the higher remarriage rate of divorced women than of widows, it might be pointed out that widows are more likely to be mothers with children than are divorced women and this lessens their chance of remarrying. If divorce is sought for the purpose of remarriage, it would seem that divorced men would remarry at a greater rate during the first year after the divorce is granted than widowers during their first year of widowhood. But the figures seem to show that they do not. Similar results appear in the statistics of Holland and Berlin. If, therefore, divorce is not sought in any great degree for the purpose of remarriage, restrictions of the remarriage of divorced persons will not tend greatly to diminish the number of divorces.

Restriction of marriage is bad for the morals of any community. About the middle of the last century, Bavaria enacted legislation requiring all men desiring to marry to show legal evidence that they could support a wife and family. In a few years the number of marriages fell

[1] BERTILLON, "Fate of the Divorced," *Journal of Royal Statistical Society*, Vol. XLVII, p. 521, September, 1884. Given in WILLCOX, "The Divorce Problem," *Columbia University Studies*, Vol. I, No. 1, p. 27.

In Connecticut, during each of the years 1889 and 1890, about one-third as many divorced persons remarried during the year as were granted divorces. HOWARD, *History of Matrimonial Institutions*, Vol. III, p. 219.

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greatly, and the number of illegitimate births increased enormously till the illegitimates were one-fourth of all children born. Alarm seized the Bavarians and in 1861 the law was repealed. Marriages increased from 38,000 to 59,000 annually and remained at this high figure for several years. The number of illegitimate births greatly decreased.[1]

There are, however, certain mild restrictions on marriage which it might be wise to enforce in the interest of public morals. It is possible to make it too easy for persons to marry. A marriage ceremony should be surrounded with a certain amount of formality, for this tends to prevent haste and recklessness in contracting matrimonial alliances. The opportunity to marry secretly is not good for the public nor the parties concerned. Neither is the common-law marriage—the simple living together of a man and woman without other ceremony—although it has the sanction of Benjamin Franklin and George Eliot. New York has passed a law declaring common-law marriage illegal. In recent years a number of instances have occurred in which, soon after the death of a well-to-do man, an adventurous woman has appeared and claimed to be his common-law wife deserted before the days of his prosperity. Such an adventuress then brings suit against the estate, and is perhaps bought off by the legitimate heirs.

What is known as the Gretna Green marriage—the young couples running away from home to a place where marriages are easily celebrated and no questions asked—is a debasing element in our society. St. Joseph, Michigan, has been a Gretna Green for Chicago for a number of years, and here a great many marriages have been clandestinely celebrated. The couple have repeatedly requested that the names be not given out. This sort of marriage can be prevented by a law requiring a license to be taken out in the county where one of the parties resides. Requiring a license is not effective if it may be taken out anywhere. Michigan has had a law requiring licenses for a number of years, but it is not such a law as tends to check the migration of persons to St. Joseph for the purpose of marrying secretly. If the license must be taken out in the county where one of the parties resides, runaway marriages will

[1] WILLCOX, *The Divorce Problem*, p. 60.

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be less encouraged. Moreover, such a requirement is no restriction on those who honestly desire to marry.

Of late there has been quite a literature on the subject of divorce from the biological point of view. These writers claim that children should be born in the best of family conditions and that if the husband and wife can only tolerate each other and have no affection, it is for the best interest of society to have them separate and remarry other and more congenial persons. Thus, it is said, healthier children will be born. It has also been contended that the woman who is married to an insane, epileptic or drunken husband, and who bears children by him, commits a crime against society. There is probably some truth in this doctrine, but it seems that it is easily carried to great extremes. Whether the evil to society from children born in families like those described above is greater than the evil from children born of parents on whom the binding effect of the marriage tie is very slight may well be questioned. From an evolutionary point of view, it is not difficult to believe that a society might be developed that would have but scant regard for the marriage vows.

The worst thing about the question of divorce in the United States is the unsettled condition of public sentiment in regard to it. At present there is no agreement in regard to divorce in the laws of the various states, nor is there much scientific study of the question. The practical thing to be done is to ascertain some of the remedies that are likely to be effective in checking reckless divorce and in creating a more sound and healthy public sentiment concerning it. Rather than any specific reform advocated to give immediate results, it seems that the remedies are general and indirect. Some of the measures that will, perhaps, in the long run tend to lessen the number of divorces are the following:

First, the growth of the romantic ideal. By this is meant that each person shall be free to follow his own inclinations in the selection of a husband or wife. A marriage is more apt to last longer if the parties to it are allowed full freedom in the choice they make. Especially is this true in a democratic society where the ideal of the political system is the opportunity for each individual to develop in his own way. Such being the case, everything that increases the opportunities for young men and

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women to know each other, will lead them to make wiser selections of their life mates.

Of the various agencies affording opportunities for young people to become acquainted, the public educational system is the most important. Of this system the high school is the greatest factor. It is to be regretted that so many of the boys do not remain in the high school to complete the course. It is hoped that the insertion into the curriculum of industrial studies, studies that will prove immediately useful in earning a living, will in the future tend to attract the boys and young men to these courses and incidentally enlarge their acquaintance with young women. It is perhaps this feature that constitutes one of the chief advantages in coeducation.

The public school does not exist solely for the purpose of teaching certain subjects. It is a great democratic institution and the enlargement of acquaintance among the young men and women is one of its great services. The social feature of education creates a larger field from which to select the future husband or wife and thus makes for the stability of the family. Ruskin said a man should know a woman seven years before he married her and our system of education makes this almost possible.

Second, obstacles to the employment of women in commerce and industry should be removed. Women go into industry to become in some degree independent and also for the sake of the social opportunities that come to them while employed in this field. Therefore, everything that tends to reduce their wages, or make less inviting the conditions under which they work may lead young women to marry recklessly in the hope of getting a home. If, as seems to be the tendency, non-support is to be dropped from the list of causes for which divorce may be granted, improvement in the conditions of woman's labor is highly important.[1] Higher wages and the restriction of child labor are therefore greatly to be desired.

Third, some improvement should be made in the law under which divorces are granted. There has been much agitation for a uniform law

[1] *Report of Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 73.

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and it is probable that such a law might have some effect in tending to check migratory divorce. It would also prevent much of the confusion which at present results from the conflict of laws concerning divorce in the various states. It is doubtful whether such a law would tend to check divorce greatly or reduce the number of divorces now granted in the most liberal parts of the country to the number which are annually granted in the New England states or New York. The evidence is all against the idea that uniformity of law on the subject of divorce tends to even up the number of divorces granted in the various parts of the country. Switzerland adopted a uniform divorce law in 1876. Ten years later, in 1885, Appenzell, Outer Rhodes, one of the cantons, had a divorce rate forty-nine times greater than that of Unterwalden. The same differences in different parts of the country existed as they did before the law was enacted.[1]

To the passage of a uniform divorce law by Congress, legal opinion seems to be opposed. Such a law is considered impracticable. It is claimed that it would lead to federal usurpation of the whole subject of domestic relations and still further congest the federal judiciary. "The federal government can never assume jurisdiction of marriage and divorce in the slightest degree, without absorbing eventually all the power incidental to the subject including family relations, property relations of husband and wife, guardianship of minors, custody and maintenance of children, legitimacy," and domestic relations generally.[2] Such are the views of the state boards of commissioners for promoting uniformity of legislation in the United States and also of the national congress on uniform divorce laws.[3]

Probably the best law that has been proposed is one requiring a two-years' residence in the state before application for divorce is allowed. It also provides that the case shall be heard in open court and before the judge personally. The court is given discretionary power to appoint someone to represent the state in uncontested cases, and cross-examine

[1] WILLCOX, *The Divorce Problem*, p. 59.

[2] SNYDER, "The Geography of Marriage." Quoted in *Report of the Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 25.

[3] *Proceedings of the National Conference on Uniform Divorce Laws*, Washington, 1906, p. 52.

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the applicant as is done with witnesses in ordinary suits at law.[1] These are desirable reforms. The greatest evil with the procedure in granting divorces at the present time is the secrecy with which the proceeding is surrounded. In many states it is not the practice for the judge to hear the evidence himself. He usually appoints a master in chancery or referee to hear the evidence and make a report to him, and on the evidence in this report grants the decree. The master in chancery or referee frequently hears the evidence in some lawyer's private office where no one appears but the plaintiff and one or two witnesses and as a result few know anything about it till the judge acting on the report of the master or referee has granted the decree desired. If the applicant were obliged to tell the story of alleged matrimonial wrongs in open court and at the same time be questioned by an officer representing the state, it is probable that many persons who now seek divorces for whimsical causes would be content to abide in the friction necessarily resulting from all married life.

There are various views of the effect of increasing divorce. Some consider it as an indication of the disintegration of society; others offer a more optimistic explanation. In so far as the increase of divorce grants greater liberty to woman, it means her elevation. It is part of the movement that has granted to woman the right to live on a higher plane than was possible in the earlier days. When the possibility of divorce is open to every married woman, it is quite likely that this tends in some degree to protect her from harsh treatment at the hands of the husband. In no other country is the position of woman so much respected as in the United States, and it may be that this respect is in part due to the privilege our women enjoy to be divorced from the husband who will make their lives unhappy.

It is certain that societies with many divorces are not more immoral than those societies that grant few or no divorces. Though Italy grants no divorce, it is not more moral than England. No one will maintain that the United States is less moral than Europe, although its divorce rate is very much higher. Nor is it true that the eastern and southern

[1] *Report of the Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 14.

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states which grant few divorces are more moral than the northern and western states where divorces are more numerous. If we judge by the age of consent, this has generally been higher in the northern and western states. Until quite recently, South Carolina which grants no divorce fixed the age of consent at ten years.[1] It is true that the increase of divorce has not as yet indicated a decay of morals.

From the above study of the principal features of the divorce problem, it appears that the modern increase in family dissolution is a result of the movement for greater individual liberty. As we are still in a period of transition, it is likely that in the future there will be some increase in the number of divorces. It is unlikely, however, that the increase will seriously menace the family as an institution. After we have passed the transition period of liberty and our society has become more settled, divorce will probably cease to increase. It seems hardly probable, however, that modern society will ever revert to a condition when divorce will be granted for but one cause.

[1] HOWARD, *History of Matrimonial Institutions*, Vol. III, pp. 198–203.

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THE ENGLISH CHURCH AND THE LAY TAXES OF THE FOURTEENTH CENTURY

By James F. Willard

The later Middle Ages witnessed in England the introduction of taxation upon a national scale, which reached, at the same time, most of the classes and the greater part of the wealth of the kingdom. This was, however, only after a long period of experiment and failure with other and less comprehensive forms. The old land taxes, the danegeld and the carucage, had proven inadequate, feudal levies only reached at best a limited number of people and the tallage was only levied upon the towns and lands within the royal demesne. Yet the total revenue from these taxes and from the more permanent sources of income, such as those from the courts and the sheriff's ferm, was insufficient to supply the needs of the government. Gradually because of its manifold advantages, the taxation of personal property superseded the older forms. This new plan of taxation, first introduced by Henry II, reached all classes of laymen, the villein, the freeman in town or country and the upper classes. It was assessed upon all kinds of movable goods in or about the homes of the people, their grain, cattle, household utensils or goods for sale. Such taxes, or subsidies, were granted in varying percentages of the value of this personal property, a tenth, a fifteenth, a twentieth or other rate. In the early fourteenth century it became customary to make a distinction between the borough and the county rate, the former being always the higher. After the year 1332 this became stereotyped, the boroughs always paying a tenth, the counties a fifteenth.[1]

When, during the reign of Henry III, this new plan of taxation had become a permanent part of the system of gaining a revenue for the government, the personal property of the clergy, always excluding certain articles in use in the churches, was taxed with that of the laity. At first

[1] The question of the real as opposed to the theoretical rate of taxation cannot be discussed in this paper. The assessments of the thirteenth and the fourteenth centuries like those of to-day seem to have been at times nominal. Only on this basis could these extremely heavy levies have been borne.

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there seems to have been no attempt made to include their spiritual property or revenue, their tithes, oblations and other strictly ecclesiastical sources of income, within the assessment of the lay taxes. These, their spiritualities, are always distinguished from their temporalities, their lands and rents. The latter they owned as any layman might hold them. During the thirteenth century the popes began to demand taxes levied upon the income from both the temporalities and spiritualities of the clergy of England for crusades or for the expenses of the papal court. Following the example of the head of the church, Henry III, from time to time, demanded similar grants from the clergy for the national expenses. In response to these demands, the clerical estate, though often reluctantly, conceded taxes upon its revenues both spiritual and temporal.

This process of development was brought to a sudden close in the year 1291. In that year, the twentieth of the reign of Edward I, upon the command of Pope Nicholas IV, there was taken an assessment of all of the revenues of the clergy of England, in order that a tenth of the same revenues might be used for the support of a crusade to the Holy Land. The results of this assessment were set forth in full in the book known as the "Taxatio Ecclesiastica."[2] This valuation of ecclesiastical property was accepted by the king as the basis for all future grants by the clergy down to the time of Henry VIII. In the fourteenth and fifteenth centuries, a grant of a tenth by the clergy meant, not that proportion of the real value of their income, but a fixed sum, the tenth part of their revenue as assessed in 1291. No provision was made, even in later years, for any increase of this total to correspond to the growing wealth of the church. If, however, a church lost a part of its income through fire, flood, war or other disaster, it might have its assessment lowered. Such was the case with the northern dioceses after the inroads of the Scots during the reign of Edward II had devastated that district. By such means the value of the grants made by the clergy gradually decreased and the assessment of 1291, was to that extent modified.

This settlement was accepted by the clergy of England and when parliament granted taxes upon the laity in 1294, 1295 and 1296 the first

[2] Printed by the Record Commission in 1802.

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estate offered separate grants for their order, based upon the Taxatio.[1] Those who did not join with them were to have their personal property taxed with that of the laymen. After the year 1297, when occurred the famous struggle with Pope Boniface VIII over the right of the king to demand taxes from the church, the central government had no further difficulty on this score. The custom thereafter was for the clergy, either in parliament or in convocation, to grant all levies upon their own order, these taxes being collected by ecclesiastics. The individual protestors, met with in large numbers in 1297, thereafter became of no moment.

Very soon a new difficulty, and a very obvious one, arose. As the years passed the church continued to accumulate wealth, through the gifts of pious donors, but, as has been mentioned, no provision was made in the Taxatio for the taxation of such new sources of income. Unless some new plan was introduced this property would wholly escape taxation, or, by being included in that which paid to the clerical grants, would lower the rate of such levies. As the church was the most wealthy of all corporations in England such a result would seem manifestly unfair. The solution of the problem during the reign of Edward I was extremely simple. In the royal instructions to the collectors of the parliamentary subsidy of the year 1297, a tax upon personal property, they are told that, "this taxation shall be made upon the goods of the clergy as upon those of the laity, the which goods are not annexed to their churches."[2] This phrase meant that the clergy were to pay to the lay subsidy for all personal property on lands acquired since 1291, which lands would not be taxed under the clerical grants. Those temporalities included in the taxation of Pope Nicholas were thereafter known as being "annexed to their spiritualities," or "annexed to their churches," the former being the most common form. This principle persisted throughout the reigns of Edward I and Edward II.[3]

The practice used in the collection of the lay taxes during the reigns

[1] *Rotuli Parliamentorum*, Vol. I, p. 227; VINCENT, *Lancashire Lay Subsidies*, Vol. I, p. 189; *ibid.*, Vol. I, p. 192.

[2] *Rot. Parl.*, Vol. I, p. 240 *b*.

[3] The phrase in 1306 is slightly different, the clergy being taxed for their lay fiefs, "lai fe," though so far as I have been able to discover there was no change in practice. *Rot. Parl.*, Vol. I, p. 270 *a*.

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mentioned shows that this principle was carried strictly into effect. On all the taxation rolls of the reign of Edward II, which have been examined, there are the names of numerous ecclesiastics paying lay taxes for their personal property.[1] On the close rolls of the same period are also to be found the records of disputes as to the liability of the clergy to be assessed for such taxes for the personal property upon their lands.[2] The point in controversy in these cases is whether the property in question had been acquired before or after the twentieth year of Edward I. If the lands had been acquired after that date the clergy had to pay lay taxes for any personal property they might happen to possess upon those lands. In the Public Record Office there is an interesting little parchment roll recording the taxation of the manor of Eastbrandenham, belonging to the priory of St. Edmund, which clearly indicates this practice with respect to the clergy.[3] It notes the sums which the head of the manor was assessed for the various lay subsidies from 3 Edward II to 25 Edward III, with the names of those who paid these taxes. Though it was owned by the priory, Julian de Stirston who held it, paid in 1307, twenty-nine shillings and three-fourths of a penny to the subsidy of that year. As he farmed the manor, his was the personal property assessed. In 1313 the prior was charged in person with an assessment of twenty-seven shillings and ninepence. Evidently then, the priory had resumed the farming of the manor and possessed taxable personal property within its boundaries. For the remaining years of the reign of Edward II and also during the early part of that of Edward III, either the prior or the cellarer of St. Edmund paid to the lay subsidies assessed upon the kingdom.

With the advent of the next king, Edward III, in 1327, the clause relating to the taxation of the personal property of the clergy, upon their lands not assessed in the Taxatio, disappears from the instructions sent out to the collectors of the lay subsidies.[4] It does not reappear until the reign of Richard II, though at that time in a slightly different form.

[1] E. g., *Cambridge Gild Records*, edited by M. Bateson, pp. 151 *et seq.*; Exchequer Lay Subsidy, 107/10, m. 1, where the names of certain ecclesiastics are stricken out because their [goods] were taxed among the spiritualities."

[2] E. g., *Calendar Close Rolls, 1307–13*, p. 17; *ibid.*, p. 179; *C. C. R., 1313–18*, p. 158; *C. C. R., 1318–23*: pp. 647–48.

[3] Exchequer Lay Subsidy, 149/6.

[4] *Rot. Parl.*, Vol. II, p. 426 *b*.

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It is, therefore, an interesting problem to account for the taxation of the movable property of the clergy upon lands not valued in 1291, during this intervening period. As the church continued to acquire lands during Edward's reign, the interest is not simply in a past difficulty.

Those records of the reign of Edward III, which have been examined, show clearly, that in spite of the absence of any definite directions to the collectors of the lay subsidies, the practice of the previous reigns continued in force. The evidence of such a condition of affairs is found on all sides, in such rolls of the lay taxes as remain to us, in the manorial accounts and the records of the officials of the ecclesiastical corporations, and more abundantly in the various enrolments of royal and other letters.

There are extant for the first two lay taxes of the reign of Edward III a large number of rolls giving the names of all those who paid to these subsidies.[1] A careful examination of these reveals the names of a number of ecclesiastics paying their share of these purely lay taxes. In many cases the fact that lands owned by the clergy are included on these lists is, doubtless, not to be discovered because of the fact that bailiffs or others were acting as their agents in the farming of these lands. In this case the bailiff's name alone might appear. After the year 1332 the rolls of the names of those who paid to the lay subsidies were no longer made up and it is necessary to rely upon other sources of information. The account already noted for the priory of St. Edmund covers the succeeding period down to the twenty-fifth year of Edward III, showing in this individual case, at least, a continuity of practice. The remarkable series of bailiffs' accounts preserved in the archives of Merton College, Oxford, however, cover the whole of Edward's reign.[2] In the case of

[1] *North Riding Record Society*, new series, Vol. IV, pp. 153, 155, 160, 161, etc.; *Associated Archit. Societies*, Reports and Papers, "Earliest Leicestershire Lay Subsidy Roll, 1327," ed. W. G. D. Fletcher, Vol. XX, pp. 16, 53, 85, 99, 100, 101, 124, 125, 130, 154, etc.; *William Salt Archæol. Society*, Vol. X, pp. 83, 105, 108, 110, etc. An examination of the manuscript rolls gives the same results. For example, the Cambridge roll of 1334, Exchequer Lay Subsidy, 81/10; for Kent, Exchequer Lay Subsidy, 149/9, m. 76 *et passim*. With the latter compare Pipe Roll, number 180 m. 3 d.

[2] They are partially summarized by THOROLD ROGERS, in his *Agriculture and Prices*, Vol. II, pp 560–65. Owing to the brevity of his account I have checked up his figures in some cases. The entries run somewhat as follows: In the account of the bailiff of the manor of Cheddington, 6–7 Edward III, under expenses there is the following: "Item in expensis taxatorum XV^{e}, II s. II d. Item in dono eisdem III s. III. d. Item solut' taxatorum XV^{e} pro manerio de Chetyndon XVIII s. II. d. ob.'" Merton College MSS. 5564 (Manoria Records).

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these manors farmed by the college through its bailiffs, there is noted the payment of all kinds of lay taxes, taxes upon personal property, and taxes upon wool, among others. In this case again the persistence in practice is shown, for the colleges had to gain licenses to acquire land in mortmain and were regarded as ecclesiastical corporations. Certain of the account rolls of the monastic houses contain occasional references to the payment by the official representatives of these houses of the same sort of taxes, evidently for lands acquired after 1291.[1]

The most fruitful sources of information are, however, the various rolls upon which the royal writs are registered, the records of the letters patent and close that were sent out into the kingdom. In the year 1327, the first in which the old clause with respect to the clergy was omitted, the Abbot of Ramsey complained that his temporalities annexed to his spiritualities were being taxed by the collectors of the lay subsidy granted in parliament, although he was accustomed to pay only clerical tenths for the same. A royal letter was immediately issued commanding the collectors to put a stop to such action.[2] An excellent commentary upon the continuance of the older practice is the statement annexed to the grant of the clergy in convocation during the same year, that their tenth was to be levied "of their ecclesiastical goods and of their temporalities annexed to their spiritualities."[3]

During the years that follow the rolls contain many settlements of the status of the lands of the clergy and decisions of disputes as to whether the land was acquired before or after the twentieth year of Edward I.[4] In 1341 and the following years there is an especially long list of exemplifications or statements of the goods of the ecclesiastical

[1] *Accounts of the Obedientiars of Abingdon Abbey, Camden Society*, Vol. CXXXVI, p. 8: "Expense apud Drayton. In XV° Domini Regis VIII s. IX d."; Chronicon *Abbatiae Rameseiensis* (Rolls Series), appendix, 353, payments for the wool subsidy.

[2] *Cartularium Monasterii de Rameseia* (Rolls Series), Vol. III, p. 31. In the accounts of the collectors of the subsidy, printed on pages 30–31 of the above work, it is noted that the goods of the abbot were excused because of this writ from the king.

[3] *Letters from the Northern Registers* (Rolls Series), p. 349.

[4] K. R. Memoranda Roll, No. 111 (10 Edward III), m. 27; The prioress of Elnestowe claims that the collectors of the 15th are attempting to tax the goods of the priory although all its lands are temporalities annexed to spiritualities. *Ibid.*, m. 27*d*, a similar complaint by the abbot of Wouburn. In the patent rolls we have an inspeximus of the temporalities of the abbot which are taxed in the clerical tenth, *C. P. R., 1334–38*, pp. 492–93. *Ibid.*, m. 174, where the Prior of St. John of Jerusalem in England claims that all of the goods of the order have always been taxed with the laity. Cf. *Rot. Parl.*, Vol. II, p. 98; K. R. Mem. Roll, No. 110, m. 134*d*, 185*d*; *C. C. R., 1339–41*, pp. 430, 485, etc.

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corporations which were taxed when tenths were granted by the clergy.[1] These writs were issued for the protection of these bodies from the assessors and collectors of the ninth, a new form of tax from which the clergy evidently thought that they had something to fear. The last statement is borne out by their petition to the crown in the parliament of 1341, in which they pray for a just statement of their position under the ninth.[2] In his answer to the petition the king simply states the existing practice as it is known with respect to other taxes, that, if the clergy have temporal possessions not taxed under the clerical tenths, they should pay the ninth upon them, so that for goods for which they pay under the one tax they will not have to pay under the other.[3] It is perfectly clear why the exemplifications were so eagerly sought from the king at this time, and why the clergy who wrote the chronicles raised no outcry against this settlement. If there had been anything new in this inclusion of certain of the temporal goods of the ecclesiastics within the property taxable by parliament there would surely have been much complaint against royal oppression. In after-years there are to be found occasional exemplifications of a like nature and other references to the liability of the clergy to be taxed with the laity for personal property upon a part of their landed possessions.[4]

When the next new type of lay taxation, the parish tax of 1371, was to be levied according to the revised rating of 116 shillings to the parish, it is noted on the rolls of parliament and also in the writs to the collectors, that the county of Chester and the lands and possessions of Holy Church, acquired before 20 Edward I, and taxed in the tenth, were to be excepted from this levy.[5] As Chester never contributed to the

[1] E. g., *Calendar Patent Rolls, 1340–43*, pp. 300, 343, 350, 371, 376–7, 421, 469, 520, etc.

[2] *Rot. Parl.*, Vol. II, p. 129.

[3] *Rot. Parl.*, Vol. II, p. 130 *a*. In the year book for the year 1343 there is an interesting case, in which the prior of Huntingdon is involved, which serves as a commentary upon this taxation. *Year Book* 17 *Edward III* (Rolls Series), pp. 598–603. See also *Calendar Patent Rolls, 1343–45*, p. 565.

[4] *Calendar Patent Rolls, 1343–45*, pp. 260, 565; *Memorials of Ripon*, Surtees Society, Vol. I, pp. 240–41, where after an inquisition it is found that a hospital is not and has not been charged with lay taxes; ROGERS, *Agriculture and Prices*, Vol. II, p. 669; a petition of the scholars of Merton College to be freed from all lay taxes; cf., *ibid.*, 155, 156; Rot. Pat., 21 Edward III, Part I, m. 3*d*, an inquisition as to the lands held in Cambridge by the religious acquired since 20 Edward I, and as to what they paid to the king's taxes. In Kent there are several references upon the rolls to the payment by the clergy of lay taxes, Exchequer Lay Subsidies, 123/20, 123/27.

[5] *Rot. Parl.*, Vol. II, p. 304; Fine Roll, No. 172 (45 Edward III), m. 22. Cf. STUBBS, *Constitutional History of England* (ed. 1896), Vol. II, p. 443.

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national taxes of the reign of Edward III, and as the temporalities annexed to the spiritualities were never taxed under grants made by the laity in parliament, this is merely a plain statement of the existing practice on the negative side.[1] Only a few years later, in the first parliament of the reign of Richard II, that of 1377, the commons petitioned and the king granted that the clergy should contribute their share, when lay taxes were levied, for goods upon all their possessions acquired since 20 Edward I.[2] In the writs sent to the collectors of the tenth and fifteenth of that year a clause was added to that effect.[3] The silence of the chroniclers upon this move is the best kind of evidence that it was nothing new and in no way considered oppressive. If the action of the council then ruling the kingdom had been to introduce a plan of taxation that would reach church property hitherto untouched, one might well imagine the indignation of all pious churchmen throughout the realm of England.

There remains to be considered in connection with this subject the curious answer made by King Edward III to the petition of the commons in parliament in the year 1346.[4] The commons prayed that the abbots, priors and other religious, who had purchased lands or tenements since the twentieth year of Edward I, should be charged and taxed for the same with the men of the community; and in order to raise these taxes that it be possible to distrain all of their lands for which they did not pay clerical tenths. Thus far the matter is quite clear. It is quite possible that the commons feared that the religious houses might be able to escape taxation either by claiming that their lands were acquired before the year mentioned, or in some other fashion, and, on that account, desired an authoritative royal answer upon the subject. The reply of the king is not so clear. The first part accords with the existing practice as it is known: "As for this point, it appears to the council, that the religious who pay their tenths with the clergy,

[1] A statement of such a nature hardly warrants the remark of Stubbs, *op. cit.*, Vol. II, p. 443, that the chancellor reported that "all the church lands acquired since 1292 must be included among the contributors."

[2] *Rot. Parl.*, Vol. III, p. 24 *b*.

[3] Fine Roll, No. 179 (1 Richard II, Part I), m. 5. The clause reads: "necnon de viris ecclesiasticis de bonis de terris et tenementis suis post annum vicesimam dominum E. fil' Regis Henrici progenitoris nostri adquisitis."

[4] *Rot. Parl.*, Vol. II, p. 163 *a*. Cf. STUBBS, *op. cit.*, Vol. II, p. 416.

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and were accustomed so to pay before the said twentieth year, should be discharged of fifteenths for the possessions upon which they pay the tenths." The fifteenths were lay taxes, the tenths, in this instance, clerical. The following clause reads: "And for the lands upon which they pay no tenths, they should be charged with the tenths *come assiert.*" This neither conforms to the existing practice nor answers the petition of the commons. Unless we read fifteenths for tenths in the second part of the last clause it is, seemingly, a mere absurdity or an exceedingly evasive answer.

All the evidence that has been collected upon this subject bears out the conclusion that there was regularly laid upon the clergy of England, for their personal goods upon lands acquired since the twentieth year of King Edward I, the burden of sharing with the laity the national taxes granted in parliament. So far as this portion of their property was concerned, no distinction can be made between them and the mass of the laymen of the kingdom. When we read the complaints of men like Wycliffe and the commoners of the later fourteenth century, against the wealth of the church and its insufficient taxation, we must, therefore, look for the background of these attacks in other spheres of activity. That there must have been some reason, and some good reason, for these attacks, must be granted, but it is difficult to see, on this side at least, how the clergy could have been expected to pay more than the laity when parliamentary subsidies were levied.

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SHAKESPEARE AND PSYCHOGNOSIS

ESSAY IV. TYPES OF SITUATION IN "THE TEMPEST"

By Melanchthon F. Libby

In the foregoing essays on types of character, however objective exegesis may have erred, it has been impossible to miss the general determination of types, because they are definitely fixed by the author in the *Dramatis Personae.*

We now pass to a more hazardous attempt, and one in which error is impossible to be avoided, even in the selection of the types themselves, to say nothing of their significance.

As in the previous parts, I have drawn upon all available criticisms, and have found them all more or less helpful, however narrow and fragmentary. One is inclined to say of *The Tempest,* as someone has said of philosophy, that all the different views which have been expressed (perhaps some others also) would, if hammered into a consistent whole, give a true account of the matter.

I have arbitrarily selected thirty types of situation which occur in *The Tempest,* and which seem to me to offer headings for a companion study to the thirteen types of character. I have chosen these types of situation because they seem to me to represent in a more or less striking manner all the most important relations of the individual types to the social environment. And here I must make a confession which will disappoint any reader who may have rashly connected this effort at objective criticism with any counsel of perfection based upon the ways of physics and chemistry, or of Professor Pearson's *Grammar of Science;* and that is, that I do not clearly know what a type, in the sense in which I am employing the word, precisely means. A type no doubt should embody the characters of its group in some striking manner. Emerson clearly means his *Representative Men* to be types of important human groups, but he selects them in an arbitrary, though exceedingly instructive manner, and gives us no account of his ground of choice, which is indeed perhaps an unanalyzed interest in his own experience. Every-

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one will agree that the *philosopher*, the *mystic*, the *skeptic*, the *poet*, the *man of the world*, and the *writer*, are immensely significant types. But contrast these with the group in *The Tempest*, and one feels that a general and proportioned chart of psychognosis is the last thing in Emerson's mind. Then, again, are men like Plato, Swedenborg, Montaigne, Shakespeare, Napoleon, and Goethe, really *types* at all, or are they quite unique and exceptional men who reject the characters of all groups, not least of their own special groups, to be themselves? And yet this also is unsatisfactory, because manifestly each does represent a very large group distributed about an average, as all groups are, whose purposes and aspirations, qualities and defects, are quite clear only in the light of these victorious examples. The doctrine that a type represents an average example of a group certainly seems to fail when applied to literature; for, however intent a poet or novelist may be in making a generalized example of a group, it is in the very nature of art to intensify and heighten the qualities represented. Then again, art is above all selective. A "bad memory" is a special need of the artist, and this is true even of the realist. In creating ideal types all those characters of a type which are irrelevant to its representative quality are omitted.

Antonio represents intellectual egoism, yet he is far more able, intense, cruel, and selfish than the average egoist; indeed, in history, we find only a few who approach him in emphasis. In dealing with types of situation we should find the same truth. The situations are extreme rather than average types. But their supreme value is in their general proportions, the truth of the whole set of them to the whole-world picture. I agree with those who hold that enlightened men of our day have little to learn from Shakespeare concerning particular cases of human psychology; his peculiar gift to us is not his modern and specialized, but his classical and proportioned, quality. Ibsen can describe Peer Gynt; Tolstoi, Anna Karenina; but none of these recent geniuses can offer us a proportioned valuation of life.

But even Shakespeare seldom endeavors to give us a complete poetic *Weltanschauung*. When he tells a tale of jealousy, the types are selected with reference to that important, but still quite narrow, phase of human interest. In the *Midsummer Night's Dream* he did perhaps aim at

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molding and fashioning the whole lump of clay, but that was an unsophisticated effort.

What we can say of the types of *The Tempest* is that they are his final and thoroughly experienced and sophisticated effort at a complete *Weltanschauung*, in which no single, however great, human interest, but the whole human interest, call it what you will, *life*, *society*, *ethics*, *psychology*, *philosophy*, *nature*, *history*, *wisdom*, *psychognosis*, is the subject more or less consciously portrayed in his concrete dramatic method of expression. Personally I believe that in this period the dramatist was pretty conscious of the philosophic quality of his work; but I do not think this can be proved, and it is hardly in the interest of art, as we find it, to attempt such proof. The difference between this play, however, and such work as Plato's *Republic* or the *Nichomachean Ethics* seems to me to be not so great as regards method and attitude as the difference between earlier plays of Shakespeare's and these abstract writings, though I also believe that Shakespeare was a good deal of a philosopher even when he wrote the *Comedy of Errors*.

1. The Ruin *Motif*.—In the exposition of the types of character, all these types of situation have necessarily been discussed in detail, though indirectly; accordingly it will fortunately be unnecessary to follow the tedious method that has seemed necessary heretofore.

The shipwreck scene seems to me to be even superior to the celebrated first scene of *Macbeth* as a keynote of its play. It is a type of all situations which test and try the human soul, and make all masquerading and shuffling impossible. "In the reproof of fortune lies the true proof of men." The shipwreck takes on a symbolic significance, which is one of the trite metaphors of all literature. We have read of the "ship of state" (cf. Gray's *Bard*), and moral writings constantly employ such similitudes as *haven*, *harbor*, *storm*, *course*, *breakers*, *full sail*. *Shipwreck of fortune* is a common phrase. In private life, the scene suggests bankruptcy, "loss of grip" in a profession, disaster to reputation, scandal and disgrace, as in the story of *Faust*—any of the grand catastrophes or failures that suggest despair and suicide even to the strong and innocent; in national life, overwhelming defeats in war, such as the collapse of France in 1870; the loss of commerce, such as ruined the Italian cities;

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the downfall of great causes, such as reduced to prostration the southern states in 1865; the wiping out of cities by fire or earthquake; the devastation of pestilence, such as that of England by the Black Plague in the fourteenth century. These examples will suggest enough to establish the typical quality of the scene, and the great men in private and national life who, like the heroes of the city of Chicago, or the statesmen of the French Republic, or Heine struggling with disease, have kept their minds above fate and have met difficulties with courage, will be seen to correspond to the better characters of the scene. The best *Weltanschauung* may not represent the life of man as a tempest, but it begins by so representing it. That is the keynote. The world is full of peril; wisdom is not in easy-going optimism; pedagogy should train children to expect battle, and to accustom themselves to struggle and to sleep on the field of battle. If the piping times of peace should actually make up the greater part of the play, yet it is because of the courage and the protection of those who would bear themselves best in storm and stress. Peace is a positive not a negative state, "for the rain it raineth every day."

2. The Cain *Motif*.—Those simple critics who find fault with Shakespeare for not inventing his own stories, forgetting the words of Horace, and the practice of Vergil, the multiplicity of Madonnas, and the gifts of Wilkie Collins and Conan Doyle, cannot indeed find fault with the *plot* of *The Tempest*, which seems to be very much the poet's own, but they should revel in the triteness of the *situations* of that plot which are literally as old as the hills. The dramatist would seem to have made the plot purely that he might be free to give shape and proportion to the very platitudes of story-telling with greater freedom. Proportion or a set of right values is the very philosophy of art, and the lack of it chaos and failure. If there is any one supreme lesson of really great and classical work, it is that sanity and proportion are synonymous. False emphasis, eccentric valuations, perverse originality of type, are no doubt useful, and at times pleasing or interesting, notes in the whole great orchestra of art; but the classic works eschew all these, and give us that perennial truth and beauty which works not created with one eye on the whole of life can never possess, and for lack of which they narrow, dwindle, and drop out.

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I have named the situation in which Antonio hates and would murder his brother the Cain *motif*, in order to emphasize its classical, rather than its inventive, merit. The sun rises every morning, and the night comes on after sunset; but sunlight and spring and youth and night and winter and death are never called trite or stale or platitudinous. When the right genius comes to his own, these are still the supreme notes in literature, but, as the *Ars Poetica* has so well said, let no third-rater attempt the tale of Troy. What greater platitude than *Crossing the Bar*, but who thinks of that, or asks for originality? It is when Tupper writes of death that we yawn.

It was Samuel Johnson himself who found this Cain story of Antonio tedious. And who will say it is not so, if we once lose hold upon the whole tragi-comedy as a mythology of human nature? But once become seized of the idea that Shakespeare is charting the world of men, drawing with a sure hand of a Greek architect the whole parallelogram of human social forces, and the more common the type, the more eager the reader. It is some similar reflection that finally makes Milton's great syntagma of names seem suddenly, not arid pedantry, but a glorious illumination of history. Our tediousness comes, not from the great poets, but from ourselves.

It would be a work of supererogation to suggest the broad typical value of the Cain *motif*, and it is no part of our purpose to trace the legend genetically. What Antonio is in human character the Cain *motif* is in human environment. The deadly animosities of social, professional, and family life; the ruinous hatred of commercial, municipal, and political life; the unscrupulous wars between nations for purposes of aggrandizement, vanity, and lust of conquest, make a great part of every biography and history obscure or famous. Wherever the bonds of sympathy or justice have snapped we find the story of Cain repeated.

3. The Exile *Motif*.—The art of this most Greek of Gothic dramas is so repressed that the pathos of the exile of Prospero might easily be missed. In the story of Dante we may read this phase of Prospero. The loneliness of idealists has been sung over and over in modern romantic writing—by Coleridge in the *Ancient Mariner*, by Byron in the *Childe Harold*, by Emerson; indeed, by nearly every poet of modern

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times. But, as Theodore Vischer has said, Shakespeare is not inclined to this kind of self-pitying tenderness; even at his finest and gentlest he is strong and robust. In this play there is no desire to appeal to any but the largest, strongest emotions. And yet, when these by prolonged reading are discovered to be repressed and implied, they break upon us with tenfold force.

What sorrows of Werther, or of the *In Memoriam*, or of any modern pathetic writing, are comparable to the sorrows of Prospero? All losses have been his. His kingdom is lost; his wife is dead; his loneliness, materially, intellectually, socially, are complete; his sensitiveness and imagination are infinite. His love and desire for love can be measured by his labors for others, his persistent obstinacy in a hopelessly unworldly ambition, his actual sacrifice of all that others put first. Only the greatest have been wanderers in exile in the entire sense of this situation; but how many of these? This is the situation of all who are misunderstood in the sincere sense of the phrase. And the group concerned is not made up only of the most gifted, but of all who in fainter colors resemble them.

4. The Power *Motif*.—There is a striking likeness between the aims of Prospero and the aims of Bacon. The *New Atlantis* might have been suggested by the island and cell of Prospero. Bacon would restore and multiply the power which the Greek world had achieved by an increase of real knowledge—the knowledge that is workable, and that controls and eliminates chance and superstition. Prospero had lost his kingdom, famed for the liberal arts; he regains it by a study of natural forces. His very name suggests Bacon's favorite dream. If there is too much of the supernatural element in the island, this is owing to the poetic fancy of Shakespeare; and it must not be forgotten that Bacon was far from emancipated from similar ideas even in his most scientific works. Modern science freed itself very gradually from the penchant for magic; indeed, is not entirely free yet, as the teleological remarks in our textbooks, and the belief in spiritualism, testify. And, then, is there not more of the marvelous in valid science than we need to justify the feats of Prospero? Would not the dramatic strokes of Marconi and Röntgen and others have been too great a tax on the imagi-

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nation even of the Elizabethans? Prospero makes his will his act immediately—that is, through no recognizable means or processes, the spirits come and go like thought itself, untrammeled by material spatial or temporal obstacles; yet how near to all this has the control of electrical energy brought us in fact! This *motif*, like most of them, recurs frequently throughout the play.

It is the type of all those situations in which learning is addressed as the truest thread through the labyrinth of life. Above all, it is the education-philosophy, the science solution, the trust in right reason and the reign of law, the *amor intellectualis Dei*, the faith that *laborare est orare*, that the gods will never do what they have enabled us to do.

It appeals to the workers in universities and all schools, and to those solitary but benevolent recluses who pursue their own lonely and laborious researches, and who neither fear nor love anything in the universe but the very truth, and the justice and well-being it confers. Its heroes include Thales and Pythagoras and Empedocles, Democritus, Aristotle, and Lucretius; bute qually Parmenides, Anaxagoras and Plato, Phidias, Pericles, Sophocles, and Cicero; Augustine, Thomas, Duns Scotus, Dante, the martyred Bruno and Campanella; and every great man in philosophy, science, art, religion, education, statesmanship, literature—all who know the meaning of the *Grammarian's Funeral;* all who have led toward law, reason, justice and enlightened liberty.

All who love and strive for power are dear to Shakespeare. Even the tyrant and murderer come within the range of his godlike breadth and sympathy, provided that they sacrifice all and die with their harness on their backs in the quest for any element of the ideal commonwealth. Is not this the explanation of his tenderness for the blood-stained Macbeth, and of our unconquerable affection for the "vulgar adventurer" (as Green calls him) Napoleon? The worship of weakness does not appeal (except as a means) to the race nor to Shakespeare.

In this fascinating portrayal of power, learning, control, natural morality, justice, reason, and prosperity, Shakespeare has indicated the very axis of his maturest *Weltanschauung;* all else, even altruistic idealism, is subordinate, temporary, pedagogical, a necessary means, to this great end.

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5. The Fatigue *Motif*.—But alas!

> The boast of heraldry, the pomp of power,
> And all that beauty, all that wealth e'er gave,
> Await alike the inevitable hour,
> The paths of glory lead but to the grave.

What are all the reason and learning of the world to the wretch entangled in those tortures from which no science can release him?

"Through forthrights and meanders," groans the weak but well-meaning Gonzalo, "I needs must rest me." He is weary and heavy-laden. And Newman echoes this sentiment and finds a wide response: "O'er moor and fen, o'er crag and torrent, till the night be gone." Also other weary and high-aspiring souls, such as Arnold in the beautiful *Rugby Chapel:*

> With frowning foreheads, with lips
> Sternly compressed, we strain on.

This *motif* leads to the highest flights of altruistic idealism. Take down the hymnbook of any church, and read the lyrics of the weary and heavy-laden; they all end in flights of angels and the joys of Eden. This is one of the most significant truths of psychognosis. Take down Haeckel's *Wonders of Life*, and certain bills presented to American state legislatures, and they advise us to destroy the weak and incurable. What does all this signify but a general confession of weakness? If the egotists who claim to be strong and to monopolize reason were really strong and possessed of the law of nature, they would have no excuse.

It would be useless to argue the value, as a typical situation, of the fatigue *motif*. All the loftiest and sweetest thoughts of the race have come from, or been inspired by, the misery and degeneracy of those who are crushed in the great transition from animal to spiritual power. All the tragic love-stories of the world—the love of Socrates for truth, of Jesus for democratic equality, of Dante for Beatrice—are echoes, or brave representations, of the world-weariness of the evolutionary army, forced in loyalty to act upon the orders of the day, yearning inwardly for the order of a perfect time. All ideals are sown in weakness, pain, disease, degeneracy, fanaticism, madness; and without this fertilization is no possible raising in learning, control, reason and power. It is

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Rachel weeping for her children, the king crying "My son, my son," who urge on the *New Atlantis*, realize *Utopia*, found universities.

6. The *Motif* of Genius in Service.—The relation of Ariel to Prospero is a symbol of the relation of geniuses, of the advanced and enlightened, to the general welfare of society. For example, is a great artist to be regarded as quite above the ordinary laws and standards of his environment—a law unto himself, a superman or *Uebermensch*, free to work or play, free to paint any and everything that pleases his imagination, free to disregard the humdrum virtues and aspirations of the dreary commonplace hordes of the Philistines? Is art its own end, and truest to itself when it bloweth where it listeth? Certainly, to oppose this view is to incur the disdain of many a fiery imagination which sees in this heresy nothing but defective vision, utterly prosaic, incompetent to judge what is not really comprehended. Read the claims of *Zarathustra*, or of Max Stirner, and of their many disciples; some, sincere and able; most, frothy and weakly. Of course, the artist is only an example. Imagination and power, as Ribot has so brilliantly shown, are not confined to art, but are found equally, or even in greater intensity, in war and statesmanship, in science and philosophy, in invention and engineering. There is a fountain of growth and playfulness in men and women of genius which keeps them exposed to the caprices of adolescence, and prevents them from settling in stable habits, often during the whole period of life. Are we to regard this as a justification of lawlessness, or merely, in the old-fashioned way, as a palliation or excuse.

On closer reflection the problem seems well-nigh insoluble. It must never be forgotten by the moralist that the poet—that is, the man or woman of imagination, the *maker*—was born "in a golden clime."

The poet has proven a thousand times that he knows more than the common-sense of the race believes. Poetry is closely analogous to faith. It is the nature of poetry to make dreams which time turns to commonplace realities. By poetry Copernicus recreated the heavens for us; by poetry Columbus failed to reach India and landed at San Salvador; by poetry Röntgen saw through opaque coverings; by poetry Hampden and Mirabeau and Jefferson brought liberty and democracy back to earth. How dare we then put habit, even good habit, even the best

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habit, above originality? Is not every evolutionist bound to revere the law-breaker, the rebel, the freaks, cranks, radicals, if only as variants, as "sports," as sporadic instances of possibly greater types than any that have been? We would lay down the law to the poet—tell him what to eat, drink, wear, do, think, feel; but he has been before us in every path.

> He saw thro' life and death, thro' good and ill,
> He saw thro' his own soul;
> The marvel of the everlasting will,
> An open scroll,
> Before him lay.
> . . . . . .
> And Freedom reared in that august Sunrise
> Her beautiful bold brow,
> When rites and forms before his burning eyes
> Melted like snow.

Truly one poor poet's scroll may shake the world—has shaken the world, over and over again. "As sure as the sun rises," says Common-Sense. "The sun stands still while the earth rotates," retorts Genius. "As certain as chalk is chalk, or cheese is cheese," says Common-Sense. "Chalk and cheese are groups of vortices in ether, or electric tensions, or perhaps dreams of will," says Genius. "Away with such monstrosities," says Common-Sense; "burn these men, crucify them, tear them limb from limb." And Genius answers, either with martyrdom or with a joke, but always with pity and contempt for our blindness: "You cannot burn the truth."

What is the conclusion of the whole matter? Common-Sense cannot tell whether any new departure is for better or for worse. In every age Genius has made departures from accepted standards of reason, faith, beauty. Nearly all these departures are condemned by results. But "the many fail, the one succeeds." One genius in many has found the right direction of progress; the army breaks camp, often after murdering the successful scout, and strikes a fresh claim into the unknown.

Is Ariel really the imaginative type in Shakespeare's *Weltanschauung*? He seems to do always the right thing, to be in harmony with the reign of law. But his rebellious attitude, his moodiness, his desire for free-

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dom *outside* of the social nexus, show that his wisdom comes from the clear science of Prospero. It is only when the inspiration of genius is controlled by the insight of science and the test of law—that is, only when fancy is controlled by the wisdom of experience, and the requirement of *workability* that it ceases to beat its wings ineffectually in the void, and *becomes* a function of progress.

[*To be continued*]

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THE BEES OF BOULDER COUNTY, COLORADO

By T. D. A. Cockerell

The bee-fauna of Boulder County has proved remarkably rich and interesting, yielding a considerable percentage of new species. It is, of course, very far from being exhausted, but the following tables are offered as a means of facilitating further progress. Various species, especially of the genus *Halictus*, are for the present omitted, as they cannot be identified until our studies of the genera they belong to have progressed further. Many species of *Halictus*, *Osmia*, and *Andrena* have been sent to Messrs. Crawford, Titus and Viereck respectively for investigation, but nothing has been learned concerning them. They will doubtless be discussed in forthcoming works by these apidologists.

The list, as it stands, numbers about 175 species. In the vicinity of Carlinville, Illinois, Robertson appears to have found about 275, after years of careful collecting. Owing to the varied conditions represented in Boulder County, it is not unlikely that the total number of species existing considerably exceeds 300. I have inserted in the tables a number of species likely to occur with us, but not yet actually found. These are distinguished by an asterisk. At some later date, I may offer a discussion of the families and genera of bees; but this does not seem very necessary at present, owing to the existence of several works covering the ground, more especially those of Robertson and Ashmead (*Trans. Amer. Entom. Society*, 1899; *Canadian Entomologist*, Feb., 1904, etc.). Cresson's *Synopsis* (1887), though old, is still very useful for determining the genera.

COLLETES Latreille

Comparatively large (length of anterior wing about 8 mm.), hair of thorax above fox-red, especially bright on scutellum, without any black intermixed (Boulder, fls. *Heuchera*) . . . . . **andrewsi** Ckll. (**simulans**, Cress., in part)?

Not so large; hair of thorax above not thus bright . . . . . 1.

1. Hair of head and pleura black (Ward, July, fls. *Drymocallis*) . **nigrifrons** Titus

Hair of head and pleura light. . . . . 2.

2. Some dark hair on thorax above, at least on scutellum . . . . . 3.

No dark hair on thorax above . . . . . 4.

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3. Larger, antennæ of male long, the joints of flagellum much longer than broad (Boulder Canyon, June) . . . . . **hydrophilus** Ckll.♂
Smaller antennæ of male much shorter, the joints of the flagellum short; punctures of abdomen very strong (Boulder, fls. *Campanula*) . . . . . **brevicornis** Rob., form **opuntiæ** Ckll.
4. Comparatively large and robust, with the hair of the thorax above yellowish or ochraceous; second submarginal cell very broad (Ward, July, fls. *Frasera*). **kincaidii** Ckll.
Smaller, with the hair pallid . . . . . 5.
5. Female; hair very pale, the abdomen with broad feltlike white apical hair-bands, and white hair on basal part of segments; malar space twice as broad as long (Ward, July, fls. *Phacelia*). . . . . **phaceliæ** Ckll.
Males, with long antennæ; hair of face white (male ***kincaidii***, if run to here, is separated by ochreous hair of face) . . . . . 6.
Males, with antennæ of the short type . . . . . 7.
6. Larger; hair of head and thorax yellowish-white (Florissant) . **sieverti** Ckll.*
Smaller; hair of head and thorax clear white (Boulder) . **salicicola geranii** Ckll.
7. Larger; hair of thorax above a little yellowish (Florissant) . **florissantia** Ckll.*
Smaller; hair of thorax above not yellowish (Florissant) . . **polemonii** Ckll.*
I had described *C. opuntiæ* as a distinct species, but Mr. Swenk gives good reasons for supposing it only a form of *brevicornis*. He has the latter from as far west as Sioux Co., Nebraska, and Missoula, Montana.
The flowers of *Petalostemon* in eastern Boulder County should be examined, with the hope of finding *C. aberrans* Ckll. and *C. wilmattæ* Ckll. The latter has red legs.

PROSOPIS Fabricius

Face entirely black; size relatively large . . . . . **basalis** Smith♀
Face not entirely black . . . . . 1.
1. Scape of antennæ heart-shaped, one side light . . . . . 2.
Scape not heart-shaped, all dark . . . . . 3.
2. Larger; anterior wing over 5 mm. . . . . **basalis** Smith♂
Smaller; anterior wing under 5 mm.; face markings cream-color. (Florissant) **antennata** Cress.♂*
3. Females; clypeus entirely dark . . . . . 4.
Males; clypeus light . . . . . 5.
4. Larger; anterior wing over 4 mm. (Boulder, May 1906, *Grant LeVeque*) **varifrons** Cress.
Smaller; anterior wing under 4 mm . . . . . **tuertonis** Ckll.
5. Lateral face marks curved above, receding from orbits (Florissant) **tridentula** Ckll.*
Lateral face-marks not curved above, or receding from orbits . . . 6.
6. Upper part of lateral face-marks very broad . . . . . **coloradensis** Ckll.
Upper part of lateral face-marks narrow and pointed (Boulder) **universitatis** Ckll.
P. basalis was found at Ward, at flowers of *Drymocallis* and *Senecio*. In South Boulder Canyon, Aug. 9, 1906, my wife and I took two male *coloradensis* and three female *tuertonis* visiting the same plant of *Solidago*. This would appear to indicate that these are the sexes of one species, but the first abdominal segment is much duller and more conspicuously punctured in *coloradensis* than in *tuertonis*.

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SPHECODES Latreille

All ours have the head and thorax black, the abdomen bright chestnut red. The table is based on females.

Small, anterior wing much less than 5 mm.; wings clear; mandibles red (Colorado Springs, etc.) . . . . . **eustictus** Ckll.*

Larger, anterior wing slightly or greatly over 5 mm. long . . . . 1.

1. When the abdomen is viewed from the side, a strong and deep constriction seen between the first and second segments; size comparatively large: wings strongly smoky (Boulder) . . . . . **pecosensis** Ckll.

Abdomen without any, or any strong, constriction between first and second segments 2.

2. Larger, anterior wing about 7 mm. long; wings strongly dusky; mandibles bidentate (Boulder, fls. *Pulsatilla*, April) . . . . . **hesperellus pulsatillæ** Ckll.

Smaller, anterior wing not over 6 mm . . . . . 3.

3. Wings practically clear; abdomen entirely red (Boulder) . . . **sophiæ** Ckll.

Wings dusky; apex of abdomen black (Florissant) . . . . **sulcatulus** Ckll.*

PROTERANER Robertson

Similar to *Sphecodes*, but the abdomen is narrow, and the males appear in the spring with the females, which is not the case with other Halictinæ. In Europe there is also a group of *Sphecodes* in which the males appear in the spring; thus the male of *S. rubicundus* v. Hag. has been taken in England in May, the male of *S. majalis* Perez in France in April. I do not possess specimens of these species, and cannot say whether they should be referred to *Proteraner*.

The Colorado species of *Proteraner* are as follows:

Male about 9 mm. long, abdomen dark red, first segment black at base, and with a large black spot on disk, apex broadly rounded (Boulder, Manitou, fls. *Ribes*) **leptanthi** Ckll.

Male about 8 mm.; abdomen narrower and lighter, the basal half of first segment black (Manitou) . . . . . **rhois** Ckll.*

HALICTUS Latreille

The table is based on females.

Head and thorax black . . . . . 1.

Head and thorax green or blue . . . . . 8.

1. Abdomen red (Northern New Mexico, fls. *Castilleia*) . . . . **ovaliceps** Ckll.*

Abdomen black, banded . . . . . 2.

2. Hind tibiæ and tarsi clear red; size large; area of metathorax granular (Boulder, fls. *Odostemon* and *Opuntia*) . . . . . **lerouxii ruborum** Ckll.

Hind tibiæ and tarsi dark, at most a little reddish, but with light hair . 3.

3. Cheeks broad, with a tooth beneath (Boulder, fls. *Odostemon* and *Senecio*) **armaticeps** Cresson.

Cheeks not toothed beneath . . . . . 4.

4. Area of metathorax with strong ridges; abdominal segments with strong white basal bands; wings very clear (Boulder) . . . . . **sisymbrii** Ckll.

Area of metathorax granular, or at most with minute feeble ridges or striæ. 5.

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5. Large, fully 11 mm. long; abdominal hair-bands on apices of segments; third submarginal cell twice as broad as second (Boulder, fls. *Pulsatilla*; *G. Weston, E. Bethel, T. & W. Ckll.*) . . . . . **lerouxii** Lep.
Smaller; hair bands wholly or mainly on bases of abdominal segments 6.
6. Wings clear, almost milky, large for size of insect; stigma amber color (Boulder, April 30, *T. & W. Ckll.*) . . . . . **aberrans** Crawford
Wings smoky . . . . . 7.
7. Larger; not shining (Boulder, fls. *Salix, Harry House*) . . **trizonatus** Cresson
Smaller; shining (Florissant) . . . . . **cooleyi** Crawford *
8. Abdomen broad, the hind margins of the segments with hair-bands; third submarginal cell more than twice as broad as second . . . . . 9.
Abdomen not thus banded; third submarginal cell not so large in proportion to second . . . . . 10.
9. Larger, abdominal bands very dense; head and thorax brassy-green (Boulder, fls. *Claytonia lanceolata*) . . . . . **arapahonum** Ckll.
Smaller, abdominal bands usually less dense; head and thorax blue-green (Boulder, fls. *Phacelia, Claytonia lanceolata*) . . . . . **melliloti** Ckll.
10. Abdomen amber-color (Florissant) . . . . . **scrophulariae** Ckll.*
Abdomen black . . . . . 11.
Abdomen green or blue . . . . . 12.
11. Smaller; area of metathorax with very fine delicate striæ on basal part (Halfway House, Pikes Peak, Sept., *Ckll.*, also Florissant) . . . . **ruidosensis** Ckll.*
Larger; area of metathorax with coarse strong ridges (Gregory Canyon, Apr. 16, fls. *Pulsatilla hirsutissima*) . . . . . **cressonii** Robertson
12. Hair of abdomen, covering segments 3 to 5, pale ochraceous (Boulder, fls. *Pulsatilla hirsutissima*, May 1, *Marie Gill*) . . . . . **pilosus** Smith, var.
Hair of abdomen white . . . . . 13.
13. Head oval, face comparatively narrow (Boulder, fls. *Senecio*, May 17, *W. P. Ckll.*) **pruinosus** Robertson
Head round, face comparatively broad (Boulder, fls. *Odostemon*, April 6, *W. P. Ckll.*) . . . . . **pruinosiformis** Crawford

The following table, adapted from Crawford, will facilitate the determination of certain males.

Species without any green . . . . . 1.
Species with more or less green; wings and nervures dark . **cressonii** Robertson
1. Face and legs entirely dark . . . . . **sisymbrii** Ckll.
Face and legs not entirely dark . . . . . 2.
2. Species with hair-bands on the apical margins of abdominal segments . 3.
Species without such hair-bands . . . . . 4.
3. Flagellum bright ferruginous beneath . . . . . **armaticeps** Cresson
Flagellum darker beneath . . . . . **lerouxii** Lep.
4. Tibiæ entirely dark . . . . . **trizonatus** Cresson
Tibiæ not entirely dark . . . . . **cooleyi** Crawford*

Mr. Crawford informs me that *H. colatus* Vachal, described from Colorado, is a male *trizonatus*.

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DIALICTUS Robertson

Like the species of *Halictus* with green or blue head and thorax, but with only two submarginal cells. The table is based on the females.

Tegulæ testaceous (Boulder, fls. *Phacelia*) . . . . . **anomalus** Robertson
Tegulæ dark . . . . . 1.

1. Bluish; abdomen with metallic luster; face narrow (Las Vegas, N. M.) **theodori** Crawford*
Greenish; abdomen without metallic luster; face broader (Boulder, fls. *Drymocallis*) **occidentalis** Crawford

I have not now access to the type of *D. theodori*, but it occurs to me as just possible that it is an aberration of *Halictus semicæruleus*.

AUGOCHLORA Smith

Comparatively large and robust; hind margin of second abdominal segment finely ciliate (Boulder). . . . . **fervida** Smith.
Much smaller, not so robust (Boulder, fls. *Hydrophyllum*, May 18. *Ckll.* S. Boulder Canyon, fls. *Grindelia*, Aug 9, *W. P. Ckll.*) . **confusa coloradensis** (Titus)
A variety of the ♂ of *A. confusa coloradensis*, with the flagellum dark, was taken in S. Boulder Canyon, fls. *Aster lævis*, Aug. 9. (*W. P. Ckll.*)

AGAPOSTEMON Smith

Females . . . . . 1.
Males . . . . . 5.

1. Abdomen green or bluish . . . . . 2.
Abdomen black . . . . . 4.
2. Mesothorax with punctures of two sizes . . . . . 3.
Mesothorax uniformly punctured or roughened (Colorado etc.) **splendens** Lep.*
3. Base of metathorax without a distinct triangular inclosure, the longitudinal ridges strong (Boulder, fls. *Carduus* oc.) . . . . . **texanus** Cresson
Base of metathorax with a more or less evident triangular inclosure, the longitudinal ridges weaker (Boulder, April, fls. *Claytonia lanceolata* and *Pulsatilla hirsutissima*) . . . . . **texanus subtilior** Ckll.
4. Larger, 12–14 mm. long; head and thorax bluish (Boulder, fls. *Carduus, W. P. Ckll.*) . . . . . **coloradensis** Crawford
Smaller; head and thorax green (Boulder, fls. *Carduus, Linum lewisii* and *Tradescantia universitatis*) . . . . . **viridulus** (Fabricius)
5. Hind femora greatly swollen or incrassate . . . . . **splendens** Lep.*
Hind femora only slightly or not swollen . . . . . 6.
6. Last ventral segment with a median carina . . . . . **viridulus** (Fabricius)
Last ventral segment without a median carina . . . . . **texanus** Cresson

The above table is adapted from that of Crawford. The males have the abdomen banded with black and yellow, and look very unlike the females.

NOMIA Latreille

Abdomen black, with light pearly-green bands (Colorado etc.) **foxii** Dalla Torre*
Abdomen without such bands; tibiæ of male ferruginous; tegulæ amber-color (Fort Collins, fls. *Solidago*, August) . . . . . **bakeri** Ckll.*

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DIANDRENA Cockerell

Similar to *Andrena*, but with only two submarginal cells.

Male 8 mm. long, olive-green; legs, antennæ and mandibles black; female just over 9 mm. long, olive-green to bluish-green (Boulder, in May) **nothocalaidis** Ckll.

ANDRENA Fabricius

Females . . . . . 1.
Males . . . . . 25.

1. Thorax and first four segments of abdomen above covered with bright fox-red hair (Boulder, *G. Hite*) . . . . . **hitei** Ckll.
   Not so . . . . . 2.
2. Tegument of abdomen red, more or less marked with black . . . 3.
   Tegument of abdomen not red . . . . . 4.
3. Pubescence fulvous; basal joints of antennæ more or less strongly ferruginous (Boulder, fls. *Pulsatilla*, May 2, *Marie Gill*) . . . . . **prunorum** Ckll.
   Pubescence usually paler; antennæ entirely dark (Boulder, fls. *Pulsatilla* and *Odostemon*) . . . . . **prunorum gillettei** Ckll.
4. Black, with entirely black hair (Boulder, fls. *Ribes*) . . . . **porterae** Ckll.
   At least some of the hair not black . . . . . 5.
5. Abdomen with a decided metallic (greenish or bluish) tint; rather small species, about 9 mm. long, with rather weak white hair-bands on abdomen . . . 6.
   Abdomen not metallic . . . . . 7.
6. Stigma amber-color or ferruginous (Boulder, fls. *Salix*, *H. House* and *Ckll.*, also fls. *Odostemon*) . . . . . **candida** Smith.
   Stigma dark (Boulder, fls. *Hydrophyllum*, May 22, *Ckll.*) . **geranii** Robertson
7. Hind tarsi clear-red; hind tibiæ largely or wholly red . . . . 8.
   Hind tarsi and tibiæ (excluding the hair) brown or black . . . 10.
8. Thorax above covered with fulvous hair; insect 8 mm. long (Boulder, June 4) **wilmattae** Ckll.
   Thorax above with whitish hair . . . . . 9.
9. Larger; punctures of mesothorax small and rather feeble (Boulder, fls. *Crataegus colorado* Ashe=*C. coloradensis* Nelson,[1] May 20) . . . **claytoniae** Robertson
   Smaller; punctures of mesothorax exceedingly large and deep (Boulder, June, *W. P. Ckll.*) . . . . . **perforatella** Ckll.
10. Hair of face and pleura black . . . . . 11.
    Hair of face wholly or mainly pale . . . . . 12.
11. Larger, about 11 mm. long; hair of thorax above fox-red; abdomen shining black, without bands (Boulder and Gregory Canyon, fls. *Odostemon*, April) **berberidis** Ckll.
    Smaller, about 8 mm. long; hair of thorax above brown; abdomen with feeble hair-bands (Boulder, fls. *Pulsatilla hirsutissima*, April 19, *Marie Gill*) . . **nigrihirta** (Ashmead)
12. Very small species, about or little over 6 mm. long . . . . . 13.
    Much larger . . . . . 14.
13. Flagellum bright red beneath (Boulder, fls. *Salix*) . . . . **salicinella** Ckll.

[1] *Crataegus colorado* has cream-colored anthers; those of *C. occidentalis* are pink.

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Flagellum dark (Boulder, fls. *Drymocallis*, May 24) . . **fragariana**, Grænicher

14. Hair-bands of abdomen very conspicuous . . . . . 15.
Hair-bands feeble or wanting . . . . . 17.

15. Larger, about 11½ mm. long; hair of thorax very yellow (Ft.Collins) . . . **mentzeliæ** Ckll.*
Smaller, hair of thorax not thus yellow . . . . . 16.

16. Punctures of abdomen stronger and closer; flagellum dark (Boulder, fls. *Pulsatilla*, April, *Marie Gill*) . . . . . **bridwelli** Ckll.
Punctures of abdomen weaker and less close; flagellum largely bright red beneath (Boulder, June, *W. P. Ckll.*) . . . . . **gardineri** Ckll.

17. Mesothorax with few, widely scattered, strong punctures (Boulder, May 21, *G. Hite*) . . . . . **nuda** Robertson
Mesothorax not so . . . . . 18.

18. Stigma very small; large species visiting sunflowers in August (Boulder, *W. P. Ckll.*) . . . . . **helianthi** Robertson
Stigma normal . . . . . 19.

19. Abdomen with long erect grayish-white hair, not hiding the surface; hair of pleura white (Boulder, fls. *Salix*, *H. House*) . . . . . **cockerelli** Grænicher
Abdomen without such hair . . . . . 20.

20. Hair of pleura black; abdomen beyond second segment with coarse black hair; first two segments and thorax above with whitish hair (Ward, July, fls. *Edwinia*) **edwiniæ** Ckll.
Hair of pleura black; abdomen beyond second segment with black hair; first two segments with very scanty dark hair; thorax above with bright fox-red hair. (Boulder, June, fls. *Lupinus*) . . . . . **lupinorum** Ckll.
Hair of pleura at least mostly black; abdomen shining black, with scanty black hair; thorax above with pale ochraceous hair (Boulder, fls. *Pulsatilla hirsutissima*, April, *E. Bethel*) . . . . . **carlini** Ckll.
Hair of pleura light . . . . . 21.

21. Area of metathorax coarsely sculptured; abdomen strongly though finely punctured; hair at apex of abdomen red (Boulder, *S. A. Rohwer*) . . **cratægi** Robertson
Area of metathorax granular, or feebly plicatulate toward base . . 22.

22. Hair at apex of abdomen black or sooty, of thorax above whitish or ochraceous. 23.
Hair at apex of abdomen red . . . . . 24.

23. Much larger, anterior wing about 10 mm., abdomen black without conspicuous hair (Castle Rock, Boulder Canyon, May, *S. A. Rohwer*) . . **vicina** Smith
Much smaller; first abdominal segment with some conspicuous light hair; vertex with black hair (Ward, fls. *Gilia* and *Drymocallis*) . . . . . **birtwelli** Ckll.

24. Hair of thorax above orange-fulvous, bright on scutellum (Boulder, fls. *Rubus deliciosus*, May 22, *Ckll.*) . . . . . **viburnella** Grænicher
Smaller; hair of thorax above gray, of apex of abdomen very bright red (Boulder, *W. P. Ckll.*) . . . . . **pyrura** Ckll.

25. Tegument of abdomen partly red; clypeus yellow with two black dots **prunorum gillettei** Ckll.
Tegument of abdomen not red . . . . . 26.

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26. Hair of face long and entirely black . . . . . **nigrihirta** (Ashmead)
Hair of face not, or not entirely, black . . . . . 27.
27. Clypeus and lower corners of face yellow . . . . . **bridwelli** Ckll.
Clypeus yellow, but not sides or corners of face . . . . . 28.
Clypeus not yellow . . . . . 29.
28. Malar space very large (Boulder, fls. *Ribes*) . . **leptanthi** Viereck & Cockerell
Malar space rudimentary . . . . . **helianthi** Robertson
29. Flagellum red beneath; small species . . . . . **salicinella** Ckll.
Flagellum dark . . . . . 30.
30. Very small, little over 5 mm. long . . . . . **fragariana** Grænicher
Larger . . . . . 31.
31. Abdomen with a purplish tint, and thin white hair-bands . **geranii** Robertson
Abdomen not metallic . . . . . 32.
32. Abdomen with broad conspicuous hair-bands; hair of thorax above very yellow **mentzeliæ** Ckll.*
Abdomen not thus banded . . . . . 33.
33. Area of metathorax coarsely sculptured . . . . . 34.
Area of metathorax granular; sides of face with black hair . . . 35.
34. Flagellum conspicuously moniliform . . . . . **claytoniæ** Robertson
Larger; flagellum hardly moniliform . . . . . **cratægi** Robertson
35. Larger; hair of thorax wholly pale, slightly yellowish . . . . . **carlini** Ckll.
Smaller; hair of thorax grayish-white, with some black . **cockerelli** Grænicher

A female of *A. prunorum gillettei*, taken at Boulder, May 11, at flowers of *Salix*, is peculiar for having the red on the abdomen confined to the hind margins of the segments, so that it looks like a very handsome new species.

From an observation made by my wife, there is reason to believe that *A. portera* and *A. leptanthi* are the sexes of one species, notwithstanding their entirely different appearance. If so, the insect formerly cited as the female of *leptanthi* must represent an undescribed species.

HALICTOIDES Nylander

Larger, at least 9 mm. long; intense black, face with black hair (Ward, fls. *Gilia*) **maurus** (Cresson)

Smaller, much less than 9 mm., hair of face not black (Ward, fls. *Drymocallis*) **harveyi** Ckll.

The male *harveyi* has a dense brush of pure white hair covering the clypeus. *Halictoides* looks much like *Panurginus*, but the marginal cell is pointed, not truncate.

PANURGINUS Nylander

Clypeus yellow, but no other yellow on face; first recurrent nervure almost or quite meeting first transverso-cubital; male (Ward, fls. *Drymocallis*) **cressoniellus** Ckll.
Clypeus and a large mark on each side of face yellow; male . **innuptus** Ckll.
Clypeus black, females . . . . . 1.

1. First recurrent nervure entering second submarginal cell at a considerable distance from its base; nervures ferruginous (Boulder, fls. sunflower, Aug. 8, *W. P. Ckll.*) **innuptus** Ckll.

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First recurrent nervure meeting, or almost meeting, first transverso-cubital; nervures dark . . . . . 2.

2. Flagellum ferruginous beneath . . . . . **cressoniellus** Ckll.
Flagellum dark (Ward, fls. *Calochortus*) . . . . **cressoniellus calochorti** Ckll.
P. cressoniellus (*clypeatus* Cresson) was originally based on a male. As shown above, and in more detail in *Ann. Mag. Nat. Hist.*, Feb. 1906, there are two forms of the female. The one first made known was assumed to be true *cressoniellus*, but it is not certain which really belongs to the described male, nor whether the males corresponding to the two females can be distinguished.

SPINOLIELLA Ashmead

Clypeus all light except dots and edge, face densely bearded with white hair. **australior** Ckll.♂*

Clypeus only partly light; females . . . . . 1.

1. Band on third abdominal segment always interrupted; fifth segment black, with neither lands nor spots (Fort Collins) . . . . . **australior** Ckll.*
Band on third segment usually entire; fifth segment largely pale (Florissant) **scitula** (Cresson)*

S. australior usually visits *Peritoma serrulatum*.

PERDITA Smith

Pale yellow (Denver, fls. *Nuttallia*, July, *S. N. Dunning*) . . **wootonæ** Ckll.*
At least head and thorax mainly dark . . . . . 1.

1. Abdomen light yellow, with dark bands (Ft. Collins, fls. *Peritoma*) **zebrata** Cresson*
Abdomen dark brown or black, with or without light marks . . . . 2.

2. No light supraclypeal mark . . . . . 3.
The supraclypeal region yellow (Boulder) . . . . . **affinis** Cresson♂

3. Light markings of abdomen large, oblique, some reaching lateral margin **affinis** Cresson♀
Light markings of abdomen smaller, transverse, not reaching lateral margin, in female, absent in male; female with clypeus and lateral face-marks white; male with face hairy, and lateral face-marks reduced to dots; flagellum light orange beneath in both sexes (South Boulder Canyon, many at fls. *Grindelia*, Aug. 9, *T. & W. Ckll.*) . . . . . **ignota** Ckll.
No doubt many more species of *Perdita* will eventually be found in Boulder county. *P. punctata* (Ckll.) and *P. rectangulata* Ckll. occur at flowers of *Solidago* at Ft. Collins.

GREELEYELLA Cockerell

Female about 9 mm. long, brown-black, very shiny; two submarginal cells; marginal cell broadly obliquely truncate; first recurrent nervure meeting, or almost meeting, first transverso-cubital; male with broad head and light yellow clypeus (Boulder, fls. *Malvastum*, June, *W. P. Ckll.*) . . . . . **beardsleyi** Ckll.

NOMADA Fabricius

Abdomen chestnut red, without light bands . . . . . 1.
Abdomen with conspicuous light bands . . . . . 4.

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1. Hind margins of abdominal segments black or blackish . . . . . 2.
Hind margins of abdominal segments not darkened . . . . . 3.
2. Hind margins very black; segments 4 and 5 each with two yellow spots (Boulder, June, *W. P. Ckll.*) . . . . . **packardiella** Ckll.
Hind margins not very black; no yellow spots (Boulder, April, fls. *Pulsatilla*) **pulsatillæ** Ckll.
3. Basal nervure arising far basad of transverso-medial; mandibles bidentate (Boulder, fls. *Drymocallis*) . . . . . **lepida** Cresson♀.
Basal nervure arising little basad of transverso-medial; mandibles simple; abdomen distinctly punctate (Boulder) . . . . . **martinella** Ckll.♀
4. Scutellum black; tegulæ yellow, hair of thorax above fox-red (Boulder, fls. *Ribes*) . . . . . **collinsiana** Ckll.♂
Scutellum red . . . . . 5.
Scutellum yellow; tegulæ yellow; pleura with a large yellow mark; bands of abdomen bright yellow; scape bright yellow (Boulder, June, *W. P. Ckll.*) **ornithica** Ckll.
Scutellum spotted . . . . . 6.
5. Face and antennæ red; hair of thorax above red . . . . **collinsiana** Ckll.♀
Clypeus and sides of face yellow; antennæ yellow beneath, flagellum above partly black and partly reddish (Boulder, fls. *Senecio*, June, *W. P. Ckll.*) . . **articulata dacotana** Ckll.
6. Tegulæ bright red; antennæ long, the flagellum black above and red beneath; male (Cheyenne Canyon, May, *W. P. Ckll.*) . . . . . **fragilis** Cresson*
Tegulæ yellow, with a pale or reddish spot . . . . . 7.
7. Abdominal bands cream-color; antennæ yellow beneath . . **martinella** Ckll.♂
Abdominal bands bright yellow . . . . . 8.
8. Mandibles strongly bidentate . . . . . **lepida** Cresson♂
Mandibles simple; flagellum red beneath (Boulder, fls. *Pulsatilla*, May 1, *Marie Gill*) . . . . . **subrutila** Lovell & Ckll.

Other species will doubtless be found. *N. uhleri*, Ckll., *N. coloradella* Ckll., and *N. alpha* Ckll., were described from Fort Collins; *N. gillettei* Ckll. and *N. agynia* Ckll. from Golden.

EPEOLUS Latreille

Anterior middle of mesothorax with two clean-cut club-shaped ochraceous stripes; scutellum red (Boulder, fls. *Townsendia grandiflora*, July, *W. P. Ckll.*) **interruptus** Robertson
Anterior middle of mesothorax washed with ochraceous, and with no clean-cut stripes; scutellum black (near Florissant) . . . . . **beulahensis** Ckll.*

TRIEPEOLUS Robertson

Large, length over 13 mm.; legs black; upward extension of light band at sides of second abdominal segment forming an angle with the band (within) of about 45° (Boulder, Aug. 26, 1906, *Rohwer*) . . . . . **martini** (Ckll.)
Much smaller; legs red . . . . . 1.

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1. Anterior femora bright red; lateral teeth of scutellum much smaller; apex of abdomen narrower, last ventral segment curved downward (Boulder, fls. *Grindelia*, Aug., *W. P. Ckll.*) . . . . . **grindeliæ** Ckll.
Anterior femora black above; lateral teeth of scutellum much larger; apex of abdomen broader, last ventral segment not curved downward (South Boulder Canyon, Aug. 9, 1906, *W. P. Ckll.*) . . . . . **helianthi** Robertson
Mr. Rohwer notes of *T. martini* ♀, "upper part of eyes in life lemon-yellow, rest black."

BOMBOMELECTA Patton

Thorax and basal segment of abdomen above with red hair, rest of abdomen black without spots (Boulder, fls. *Pulsatilla hirsutissima*, April, *W. P. Ckll.*) **fulvida** (Cresson)
Abdomen with six conspicuous light spots (near Ft. Collins) . **johnsoni** Ckll.*

CŒLIOXYS Latreille

Female about 12 mm. long; legs red (Boulder, fls. *Grindelia*, Aug. 20, *W. P. Ckll.*) **deplanata** Cresson

CHELYNIA Provancher

Abdomen black with ivory-colored bands (Florissant) . **monticola** (Cresson)*
Abdomen blue with whitish or very pale yellowish bands . . . . . 1.
1. Larger, abdomen with four bands; hair of pleura black (Boulder, fls. *Astragalus*, June, *W. P. Ckll.*) . . . . . **pulchra** (Crawford), var.♀
Smaller, abdomen with five bands; hair of pleura light (Florissant) **elegans** (Cresson)♂*

STELIS Panzer

Blue, with black hair; no light markings; looks like a small *Osmia* (Florissant) **montana** Cresson*

ANTHIDIUM Fabricius

Females . . . . . 1.
Males . . . . . 7.
1. Face all black . . . . . 2.
Face with light markings . . . . . 3.
2. Scutellum all black; scopa strongly stained with brown (Boulder, fls. *Psoralea tenuiflora*, Aug. 8, *W. P. Ckll.*) . . . . . **tenuifloræ** Ckll.
Scutellum with light markings; scopa white (Ward. fls. *Phacelia*) . . . **emarginatum** (Say)
3. Clypeus black, but sides of face with pale marks; scopa white (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) . . . . . **porteræ personulatum** Ckll.
Clypeus at least partly light . . . . . 4.
4. Abdominal bands entire; size large; scutellum with two yellow spots (Boulder, fls. *Helianthus lenticularis*, Aug. 29, 1906, *Rohwer*) . . . **occidentale** Cresson
Abdominal bands interrupted in the middle . . . . . 5.
5. Lateral yellow face-marks extending above level of antennæ; large species with bright yellow markings; scopa pale reddish-yellow (Ward, fls. *Phacelia*) **conspicuum** Cresson

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Lateral face-marks not extending above level of antennæ . . . . . 6.

6. Larger; yellow on clypeus interrupted in middle (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*) . . . . . **porterae** Ckll.
Smaller; yellow on clypeus not interrupted in middle; upper part of clypeus with a large W-like black mark; sixth abdominal segment bright lemon-yellow (Boulder, June, *G. Hite*) . . . . . **blanditum prædentatum** Ckll.

7. Smaller; scutellum all dark . . . . . **tenuiflorae** Ckll.
Larger; scutellum at least with yellow dots . . . . . 8.

8. Lateral face-marks extending above level of antennæ; large species; abdominal bands not interrupted in middle . . . . . **occidentale** Cresson
Lateral face-marks not extending above level of antennæ . . . . . 9.

9. Ground color of abdomen a more or less lively red; last segment red (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) . . . . . **porterae amabile** Ckll.
Ground color of abdomen dark . . . . . 10.

10. Apical segment red; size large . . . . . **porterae** Ckll.
Apical segment black . . . . . 11.

11. Abdomen spotted, though some of the spots are united by lines; axillæ with light spots . . . . . **porterae personulatum** Ckll.
Abdomen banded, though the bands are partly interrupted; axillæ without light spots . . . . . 12.

12. Markings of abdomen light yellow . . . . . **emarginatum** (Say)
Markings of abdomen deep chrome yellow (Fort Collins) . . . **titusi** Ckll.*

DIANTHIDIUM Cockerell

Females . . . . . 1.
Males . . . . . 4.

1. Legs red . . . . . 2.
Legs yellow and black, or black with yellow marks . . . . . 3.

2. Smaller; clypeus all black; scopa white (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) **concinnum** (Cresson) var.
Larger; clypeus light at sides (Boulder, fls. sunflower, Aug. 8, *W. P. Ckll.*) **sayi** Ckll.

3. Abdominal markings deep yellow; clypeus light at sides (Boulder, nesting in hole in brick wall at Kruger's house, Aug 2. *Ckll.*, South Boulder Canyon, fls. *Grindelia*, Aug. 9, *W. H. Ckll.*) . . . . . **parvum** (Cresson)
Abdominal markings very pale yellow (Boulder, September, *S. A. Rohwer*) **pudicum** (Cresson)

4. Legs red (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*) **sayi** Ckll. (*interruptum* Say)
Legs yellow and black (Boulder, fls. *Grindelia*, Sept. 3, *Ckll.*, fls. *Grindelia* and *Chrysothamnus*, Sept., *Rohwer;* S. Boulder Canyon, fls. *Grindelia*, Aug. 9) **parvum** (Cresson)

OSMIA Panzer

Females . . . . . 1.
Males . . . . . 21.

1. Black without any metallic colors; looks like *Monumetha*, but eyes diverging above;

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clypeus with a strong, smooth and shining, longitudinal median ridge (Boulder, June, *W. P. Ckll.*) . . . . . **hypocrita** Ckll.
Very brilliant blue or green; scopa black . . . . . 2.
Dark blue or green, or black with blue or purple tints. . . . . 3.

2. Abdomen long and parallel-sided; tegulæ piceous with a green spot in front (Ward, fls. *Edwinia*) . . . . . **fulgida** Cresson
Abdomen shorter; tegulæ wholly green (Boulder) . . . . . **bruneri** Ckll.

3. Large species; hair of thorax above bright fox-red; hair of clypeus and adjacent sides of face black; scopa black (Boulder, June, *W. P. Ckll.*) **novomexicana** Ckll.
Hair of thorax above not thus brilliant . . . . . 4.

4. Pubescence, including ventral scopa, white (Boulder, June, *W. P. Ckll.*) **hesperella** Ckll.
Ventral scopa reddish; edge of clypeus 4-dentate (Boulder, May, *Rohwer*) **hypochrysea rohweri** Ckll.
Ventral scopa black. . . . . 5.

5. Hair of pleura white . . . . . 6.
Hair of pleura black (white in lower part in one small species, *hypoleuca*) 9.

6. Hair of face all white (Boulder, June, *W. P. Ckll.*). . . . **coloradella** Ckll.
Hair of face not, or not all, white; small species . . . . . 7.

7. Legs metallic; vertex and face with very coarse black bristles (Ward, July, fls. *Pentstemon*) . . . . . **pentstemonis** Ckll.
Legs black . . . . . 8.

8. Scutellum with long black hairs among the white; front brightly colored (Ward, July, fls. *Phacelia:* Boulder, June, 17, *W. P. Ckll.*) . . . . **phaceliæ** Ckll.
Scutellum without black hairs; front black or very dark (Ward, July, fls. *Phacelia*) **melanotricha** Lovell & Cockerell

9. Thorax above with white hair; large species . . . . . 10.
Thorax above with black hairs among the light . . . . . 12.

10. Mandibles 4-dentate, massive; hair of pleura very short and scanty (Boulder, June 10, *W. P. Ckll.*) . . . . . **brevihirta** Ckll.
Mandibles 3-dentate; hair of pleura long . . . . . 11.

11. Second abdominal segment with much hair; abdomen dark blue (Boulder, June 9, *Ckll.;* June 17, *W. P. Ckll.*) . . . . . **nigrifrons** Cresson, var.
Second abdominal segment with black hair; abdomen very shiny, green, with the hind margins of the segments purple (Arapahoe Peak, Sept. 1, *Rohwer*) **hendersoni** Ckll.

12. Mandibles 3-dentate . . . . . 13.
Mandibles 4-dentate . . . . . 16.

13. Large species . . . . . 14.
Small or rather small species . . . . . 15.

14. (Colorado, etc.). . . . . **nigrifrons** Cresson
Differing from *nigrifrons* by having the punctures of the third abdominal segment much more distinct and separate; the hair at sides of metathorax white; a tuft of long white hair on and around tubercles; and the sides of face greener. No appressed light hair on cheeks. Length about 11½ mm. (Boulder, fls. *Gaillardia*, July 6, *W. P. Ckll.*) . . . . . **gaillardiæ** Ckll.

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15. Larger, length a little over 9 mm.; lower part of pleura without white hair; legs not metallic (Ward, July, fls. *Gilia*) . . . . . **wilmattæ** Ckll.
Smaller; lower part of pleura with white hair; legs metallic (Boulder, June 9, *W. P. Ckll.*) . . . . . **hypoleuca** Ckll.

16. Small species; hair of sides of face mixed black and white (Halfway House, Pike's Peak, fls. *Salix*, May 30) . . . . . **pikei** Ckll.*
Large species . . . . . 17.

17. Cheeks with a large tooth below; mandibles much produced; clypeus smooth and shining (Eldora, Aug. 31, fls. *Gaillardia*, *Rohwer*, Ward, fls. *Senecio* and *Frasera*) **armaticeps** Cresson
Cheeks without such a tooth below . . . . . 18.

18. Mandibles with a large outstanding basal process; clypeus deeply emarginate. (Boulder, Ward, fls. *Phacelia*) . . . . . **propinqua** Cresson
Mandibles without such a process . . . . . 19.

19. Smaller; head and thorax strongly blue and green; base and sides of second abdominal segment with short white pubescence (Boulder, June 12, *W. P. Ckll.*) **senior** Ckll.
Larger; head and thorax very dark; hair at base of second abdominal segment black . . . . . 20.

20. Smaller; clypeus densely punctured (Ward, July, fls. *Senecio*) . . **wardiana** Ckll.
Very large and robust; clypeus with well-separated punctures (Boulder, fls. *Carduus*, *Ckll.*; Boulder, June 22, *G. Hite.*) . . . . . **pascoensis** Ckll., var.

21. Black . . . . . here should come the unknown ♂ of **hypocrita**
Dark blue or green . . . . . 22.

22. Vertex with hair wholly pale . . . . . 23.
Vertex with hair at least partly black . . . . . 25.

23. Very small; hair of hind femora white; legs metallic; hind margins of abdominal segments dark; flagellum darker than in typical *proxima* (Boulder, fls. *Phacelia*, June 12, 1905, *W. P. Ckll.*) . . . . . **proxima** Cresson, var.
Hair of hind femora black . . . . . 24.

24. Small, green, with small ocelli and narrow face (Boulder, June 4, *W. P. Ckll.*) **wheeleri** Ckll., var.
Larger, bluer, with large ocelli (Boulder, June 4, 9 and 10, *W. P. Ckll.*) . . **cyaneonitens** Ckll.

25. Hair of upper part of pleura largely, but not all, black; large species (Boulder, May 20, *Rohwer*) . . . . . **viridior** Ckll.
Hair of upper part of pleura all black; flagellum moniliform; hind basitarsus toothed (Boulder, April 20, fls. *Pulsatilla hirsutissima* and *Claytonia lanceolata*) species agreeing with *lignaria* Say, but as the females of this group (*Ceratosmia*) taken at Boulder are all *propinqua*, I infer that they belong to that species, the two not being separable in the male.
Hair of upper part of pleura not black . . . . . 26.

26. Larger; hair of face and thorax yellowish, the latter with long black hairs interspersed (Boulder, April 20, fls. *Pulsatilla hirsutissima*) . . . **olivacea** Ckll.
Smaller . . . . . 27.

27. Hair of face and thorax above white, the latter with black hairs interspersed; face

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narrow (Boulder, fls. *Pulsatilla hirsutissima*, April 20, *W. P. Ckll.*) **pulsatillae** Ckll.
Hair of thorax without black hairs interspersed (Boulder, April 20, fls. *Pulsatilla hirsutissima*) . . . . . **aprilina** Ckll.

MONUMETHA Cresson

Black with parallel-sided abdomen; face of male with appressed white hair (Ward, fls. *Phacelia* and *Frasera*) . . . . **albifrons** Kirby (**argentifrons** Cresson)

ALCIDAMEA Cresson

Black, about 7 mm. long; male with very thick flagellum (Boulder, fls. *Phacelia*) **simplex** Cresson

Grænicher found this species nesting in dry stems of blackberry, etc.

ASHMEADIELLA Cockerell

Female length 6 to 7 mm.; head and thorax black; abdomen black, with first dorsal segment red except a central mark, second red at sides, third partly red (Fort Collins) . . . . . **gillettei** Titus*

HERIADES Spinola

Length 8 mm. or over; black; mandibles of female with a tubercle on outer side; ventral scopa white (Boulder, fls. *Clematis ligusticifolia*, July, *W. P. Ckll.*) **gracilior** Ckll.

LITHURGUS Berthold

Large, *Megachile*-like; apex of female abdomen with red hair, of male abdomen sharply pointed (Boulder, fls. *Opuntia*) . . . . . **apicalis** Cresson

MEGACHILE Latreille

Females . . . . . 1.
Males . . . . . 11.

1. Abdomen without bands; first two dorsal segments and base of third with light hair, the others with black; scopa red . . . . . 2.
   Abdomen with more or less conspicuous hair-bands . . . . . 3.
2. Little or no black hair on vertex and mesothorax (Boulder, Aug., *W. P. Ckll.*) **wootoni** Ckll.
   With conspicuous black hair on vertex and mesothorax (Ward, fls. *Lupinus*) **wootoni calogaster** Ckll.
3. Cheeks with an enormous tooth beneath; mandibles greatly elongated (Boulder, Ward, fls. *Geranium*, *Carduus*) . . . . . **pugnata** Say
   Not so . . . . . 4.
4. Ventral scopa largely or wholly red or orange . . . . . 5.
   Ventral scopa white or creamy-white, with or without black at extreme apex 7.
5. Smaller, length less than 12 mm.; head and thorax above with some conspicuous black hair (Boulder, September, *Rohwer*) . . . . . **relativa** Cresson
   Larger, length over 13 mm. . . . . 6.
6. Abdomen heart-shaped; hair of mesothorax mainly grayish-white (Ward, South Boulder Canyon, Boulder; fls. *Phacelia*, *Senecio*, *Psoralea*, *Grindelia*) **latimanus** Say

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Abdomen narrower, oblong, shiny; hair of mesothorax largely or mainly black (Ward, Boulder, fls. *Phacelia, Grindelia*) . . . . . **vidua** Smith

7. Small, length not over 11 mm. (Boulder, fls. *Phacelia, W. P. Ckll.*) . **brevis** Say
Larger, length 12 mm. or more . . . . . 8.

8. Middle of clypeus with feeble, sparse punctures (Boulder, *W. P. Ckll.*, July 3, fls. *Opuntia*) . . . . . **opuntiarum** Ckll.
Middle of clypeus with strong punctures . . . . . 9.

9. Smaller; abdomen oblong, rather narrow; middle tarsi slender (Boulder, fls. *Argemone intermedia*, Aug. 27, *Ckll.*) . . . . . **montivaga** Cresson
Larger; abdomen broad; middle tarsi broadened . . . . . 10.

10. Larger and broader, width of abdomen 5½ mm.; pubescence white or grayish-white (Boulder, *W. P. Ckll.*, Aug. 6 to 9, fls. sunflower) . **sexdentata** Robertson
Smaller, not so broad, width of abdomen about 4½ mm.; pubescence with a yellowish tint (Boulder, fls. *Grindelia*, Aug. 21, *Ckll.*) . . . . **manifesta** Cresson

11. Abdomen without bands, hair on basal 2–2½ segments pale yellowish, beyond that black . . . . . 12.
Abdomen with evident narrow hair-bands . . . . . 13.

12. Spurs of hind tibiæ ferruginous; vertex more closely punctured . **wootoni** Ckll.
Spurs of hind tibiæ piceous; vertex less closely punctured **wootoni calogaster** Ckll.

13. Front tarsi simple . . . . . 14.
Front tarsi flattened or excavated . . . . . 16.

14. Spines on anterior coxæ reduced to short teeth or dentiform angles **montivaga** Cresson
Spines on anterior coxæ well developed . . . . . 15.

15. Mandibles 4-dentate, middle tooth notched . . . . **sexdentata** Robertson
Mandibles 3-dentate . . . . . **brevis** Say

16. End of abdomen (keel of sixth segment) with a very large deep notch; hair of face yellow; anterior femur with an oblique keel near apex on outer side . **vidua** Smith
End of abdomen (keel of sixth segment) notched; hair of face cream-color; anterior femur without a subapical keel; middle femur greatly swollen **latimanus** Say
Keel of sixth segment little or not notched; anterior tarsus with a boat-shaped scale or process . . . . . 17.

17. Spines of anterior coxæ slender; keel of sixth segment (seen in lateral view) directed caudad . . . . . **pugnata** Say
Spines of anterior coxæ broad and flattened; keel of sixth segment jagged, and directed downward . . . . . **manifesta** Cresson

MELISSODES Latreille

Females . . . . . 1.
Males; clypeus yellow . . . . . 6.

1. Very large; anterior part of mesothorax with red hair, posterior part with black, the colors contrasting (Boulder, Aug., fls. sunflower, *W. P. Ckll.*, *Rohwer*) **obliqua** Say
Colors on mesothorax different, at least not red in front . . . . . 2.

2. Scutellum without black hair . . . . . 3.
Scutellum with hair at least partly black . . . . . 4.

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3. Very large; anterior wing about 10½ mm. long; nervures dark; hair on inner side of hind basitarsus black (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*; fls. *Chrysothamnus*, Sept., *Rohwer*) . . . . . **mizeæ** Ckll.
Much smaller; nervures ferruginous (Boulder, fls. *Grindelia*, Aug. 21, *Ckll.*) **agilis** Cresson
4. Head extremely broad; hind basitarsus with long white hair on outside, and black on inner (Boulder, fls. *Opuntia*) . . . . . **pallidicincta** Ckll.
Head ordinary . . . . . 5.
5. Tuft of hair on tegulæ in front black; abdominal bands with a strong orange tint (South Boulder Canyon, fls. *Grindelia*, Aug. 9, *W. P. Ckll.*) . . **grindeliæ** Ckll.
Tuft of hair on tegulæ in front light: abdominal bands grayish white, or only faintly yellowish (Boulder, fls. *Grindelia* and sunflower, Aug. 5 to 7, *W. P. Ckll.*; fls. *Chrysothamnus graveolens*, Sept. 12, *Rohwer*) . . . . . **confusiformis** Ckll.
6. Large; about 14 mm. long; antennæ red beneath . . . . . **obliqua** Say
Much smaller . . . . . 7.
7. Mesothorax with a good deal of black hair; tegulæ with a tuft of black hair; labrum black . . . . . **grindeliæ** Ckll.
Mesothorax without black hair; small species . . . . . 8.
8. Labrum (exclusive of its hair) black; mandibles with no yellow spot; length 10 to 11 mm. (Boulder, fls. *Helianthus*, Aug. 26, *Rohwer*) . . **agilis semiagilis** Ckll.
Labrum black, with a very obscure light spot; spines at sides of last abdominal segment very short; hair of thorax above *very* pale ochreous; mandibles with a very small yellow spot (Boulder, fls. *Grindelia serrulata*, Sept. 5, *Ckll.*) **agilis** Cresson, var. a.
Labrum with a large yellow spot; insect rather large, approaching *M. menuacha*, hair of thorax above practically white; mandibles with no yellow spot (Boulder, July 29, *Ckll.*, at sunflower, Aug. 7, *W. P. Ckll.*) . . . **agilis** Cresson, var. b.
Labrum light except lateral corners; mandibles with a large yellow spot (Boulder, July 29, *Ckll.*, at sunflower, Aug. 7, *W. P. Ckll.*) . . . **agilis** Cresson, var. c.

XENOGLOSSA Smith

Thorax with reddish hair; male clypeus black with a large yellow spot; in flowers of Cucurbitaceæ . . . . . **pruinosa** Say *

TETRALONIA Spinola

Females . . . . . 1.
Males . . . . . 2.
1. Hind spur of hind tibia hooked at end (Boulder, *S. A. Johnson*) **dilecta** Cresson
Hind spur not hooked; abdomen shining black, with only one white hair-band, which is on fourth segment, but a white spot on each side of third **acerba** Cresson
2. Hair of thorax above bright rufo-fulvous (Boulder, fls. *Astragalus*, June, *W. P. Ckll.*) . . . . . **astragalina** Ckll.
Hair of thorax above pale or dull . . . . . 3.
3. Very large; the entirely black flagellum at least 11 mm. long (Fort Collins) **gillettei** Ckll.*
Not so large . . . . . 4.

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4. Hair on second abdominal segment all black (Boulder, May 21, 1906, *G. Hite*) **acerba** Cresson

Hair on second abdominal segment partly light; fifth segment with a light band (Boulder, fls. *Phacelia*, June 4, *W. P. Ckll.*) . . **edwardsii vagabunda** Ckll.

The female *acerba* has not been taken in our region. It seems possible that the male assigned to *acerba* is after all a variety of *T. edwardsii*. The specimen of *acerba* taken by Mr. Hite has the peculiarity of possessing only two submarginal cells on both sides. This, if constant, would take it out of true *Tetralonia*, and place it in the old-world genus *Eucera*.

DIADASIA Patton

Hind spur of hind tibia strongly bent at end in female; basal joint of hind tarsus ending in a long process in male (Boulder, Aug. 5, fls. *Opuntia*) **australis** Cresson

EMPHOROPSIS Ashmead

Female with a patch of black hair in middle of thorax, and outer side of hind tibiæ with orange hair; male with face-marks white (Boulder, fls. *Ribes; Mrs. Bennett*) . . . . . **johnsoni** Ckll.

ANTHOPHORA Latreille

Abdomen with white bands not due to hair (Boulder, fls. *Psoralea* and *Solanum rostratum*) . . . . . **smithii** Cresson

Abdomen without such bands . . . . . 1.

1. Thorax above with black and pale hair intermixed, giving a gray effect; middle tarsus of male with copious red hair (Boulder, fls. *Ribes* and *Viola*) **simillima** Cresson

Thorax above without black hair intermixed . . . . . 2.

2. Abdomen covered with grayish or fulvous hair; large species (Boulder, fls. *Carduus*, July 29, *Ckll.*) . . . . . **occidentalis** Cresson

Thorax and abdomen with bright fox-red hair, but apex of abdomen with black (Ward, fls. *Gilia*, South Boulder Canyon, fls. white aster, Aug. 9, *W. P. Ckll.*) **neomexicana** Ckll.

Thorax and first abdominal segment with dense fulvous hair; rest of abdomen black, with distinct narrow hair bands in male, and vestiges of bands in female (Boulder) . . . . . **montana** Cresson

CERATINA Latreille

Small; apical portion of male abdomen narrow; hind femora of male triangular; female with a light mark on clypeus (Boulder, fls. *Calochortus* and *Phacelia*) **nanula** Ckll.

Larger, more robust, female 7 to 8 mm. long; apex of male abdomen broadly triangular (Boulder, fls. *Platycodon*, *Calochortus*, *Argemone*, *Phacelia*) **neomexicana** Ckll.

PSITHYRUS Lepeletier

Large; *Bombus*-like; hair of thorax above fulvous, broadly black between the wings; abdomen shining black, with some light yellow hair at sides toward apex (Ward, fls. *Lupinus*) . . . . . **insularis** Smith

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BOMBUS Latreille

Abdomen with a very conspicuous red band . . . . . 1.
Abdomen without such a band . . . . . 6.

1. The red band subapical, with a broad black band before it, and the base of the abdomen broadly pale (Arapahoe Peak, above timber-line, Aug. 31, 1906, *W. P. Ckll.;* Eldora, fls. *Delphinium*, Sept. 1, 1906, *S. A. Rohwer*) . . **frigidus** Smith
(Titus records *frigidus* from Ward as *oregonensis*. He also reports *B. couperi* Cresson, and *B. putnami* Cresson, from Ward. These are similar in most respects to *frigidus*. I examined the types in the Cresson collection, and noted as follows: "*B. putnami* and *couperi* are very similar, with fulvous pubescence, broad black thoracic band, and very broad black abdominal band, occupying the third and fourth segments. *B. putnami* is the larger.")
The red band occupying the third and fourth segments, with no black band before it . . . . . 2.
The red band occupying the second and third segments, with a yellow or yellowish band following it . . . . . 4.

2. Abdomen beyond the red band with yellow hair; only a little black, on apex of sixth segment (Eldora, fls. *Gaillardia*, Aug. 31, *Rohwer*) . **rufocinctus** Cresson♂
Abdomen beyond the red with black hair . . . . . 3.

3. Yellow hair of thorax above without black intermixed (Boulder) **juxtus** Cresson
Yellow hair of thorax above with much black intermixed (Ward, cf. Titus; Eldora, fls. *Gaillardia*, Aug. 31, *Rohwer*, Arapahoe Peak, above timber-line, Aug. 31, *W. P. Ckll.*). . . . . **flavifrons** Cresson

4. Yellow of scutellum and first abdominal segment divided into two spots; form compact (Ward, cf. Titus; Boulder, April and May, *Rohwer*) . **bifarius** Cresson
Yellow of scutellum not divided . . . . . 5.

5. Abdomen more elongate, face with fulvous hair (Ward, cf. Titus; Boulder, August etc. *W. P. Ckll., Rohwer*) . . . . . **huntii** Greene
Abdomen heart-shaped, face with black hair, a little pale intermixed (Ward, fls. *Phacelia*) . . . . . **rufocinctus phaceliæ** (Ckll.)
(In recent years, the validity of *B. bifarius* has been questioned, but it is evidently a perfectly good species. I follow Mr. Franklin in treating *iridis*, *phaceliæ* and *astragali* as varieties of *rufocinctus*. He has accumulated a large amount of information on this group, which he will shortly publish. Mr. Titus has recorded *B. sylvicola* Kirby, and *B. mixtus* Cresson, from Ward; I have not met with them in Boulder County. *B. sylvicola* was originally described from Lat. 65° N.; the abdomen is yellow with a broad median red band; the apex is, I believe, *not* black, in which case there must be some doubt about the *sylvicola* of Mr. Titus' table (*Canad. Ent.*, 1902, p. 39). *B. mixtus* was described from Colorado; it has the black band between the wings ill-defined.)

6. Thorax black, with the anterior part broadly fulvous-haired; abdomen fulvous with the apex broadly black; large species (Boulder, *G. Weston*, at sunflower, Aug. 7, *W. P. Ckll.;* at *Melilotus alba*, Sept. 27, *Rohwer*) . . **americanorum** Fabricius
(*B. americanorum* is said by Mr. Franklin to be the same as *pennsylvanicus*, but there is much confusion about the latter; Robertson holds it to be *fervidus*, while Pierce has given *auricomus* as *pennsylvanicus*.)

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Scutellum with yellow or fulvous hair . . . . . 7.
7. No black band between the wings . . . . . 8.
A distinct black band between the wings . . . . . 12.
8. Abdomen black with first and part of second segment yellow-haired (Boulder, fls. sunflower, Aug. 9, *W. P. Ckll.*) . . . . . **separatus** Cresson
Abdomen with the yellow covering first two segments, and at least part of third 9.
9. Lower edge of yellow strongly convex; large species (Boulder, *J. Henderson*, May 11, *Rohwer*) . . . . . **morrisoni** Cresson
Lower edge of yellow straight. . . . . 10.
10. Face very narrow; apex of abdomen with reddish hair . . . . . **nevadensis** Cresson δ (*improbus* Cr.)
Face normal ; females . . . . . 11.
11. Abdomen with first three segments yellow (near S. Boulder Creek, about 7 miles from Boulder, *Youngblood*, Boulder, August, *W. P. Ckll.*) . **nevadensis** Cresson
Abdomen with the first four segments yellow (Boulder, fls. *Helianthus*, Aug., *Rohwer*) . . . . . **dorsalis** Cresson
(The male of *dorsalis* has the abdomen yellow-haired, with only the last segment and the sides of the penultimate black-haired.)
12. Thorax before the band white-haired; abdomen with the hair tawny, and no black band (Boulder, *Ckll.*, Arapahoe Peak, above timber-line, Aug. 31, *W. P. Ckll.*) **appositus** Cresson
Thorax before the band yellow or tawny-haired . . . . . 13.
13. Abdomen with the first four segments yellow-haired . . . . . 14.
Abdomen with the basal half at least mainly black-haired . . . 15.
14. Yellow of abdomen suffused with red, especially at sides; hair of face pale (Boulder, *W. P. Ckll.*). . . . . **rufosuffusus** Ckll.
Yellow of abdomen not suffused with red; hair of face black (Boulder, *G. Weston*, fls. sunflower, Aug. 6 and 7, *W. P. Ckll.*) . . . . . **fervidus** Fabricius
15. Apex of abdomen with pale hair; hair of base black . . . . . 16.
Apex of abdomen with coarse black hair, but yellow at sides of fifth segment; hair of first and part of second segment pale . . . . . 17.
16. First two and fourth segments black, apex white (Boulder, May, *Rohwer*) **proximus** Cresson
First two segments black, third yellow or tawny, fourth to sixth white (Boulder, fls. *Prunus*, May, *Chas. Sellers*) . . . . . **proximus coloradensis** Titus
17. The broad black band of abdomen with coppery-red hairs intermixed (Eldora, fls. *Gaillardia*, Aug. 31, *Rohwer*) . . . . **rufocinctus iridis** (Ckll. & Porter)
The band entirely black; appearance of *B. edwardsii* (Boulder, Ward; fls. *Astragalus, Phacelia*). . . . . **rufocinctus astragali** Ckll.

APIS L. (domesticated)

Abdomen dark (Boulder) . . . . . **mellifera** L.
Abdomen very largely rufo-fulvous (Boulder, fls. *Pulsatilla*, etc.) . . . **mellifera ligustica** Spinola.

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POSTSCRIPT

Since the above went to press, the following species have been added to the Boulder County fauna:

Andrena erythrogastra Ashm. Boulder, May 9, fls. *Taraxacum; Mrs. Bennett.*

A. bipunctata Cress. Boulder, fls. *Prunus; G. Hite.*

A. illinoensis Rob. Boulder, fls. *Taraxacum; G. Hite.*

A. pyrrhacita Ckll. Salina, *W. & T. Ckll.;* Boulder, *G. Hite.* A species with dense erect hair covering abdomen, orange-fulvous in color, except at base and apex; much black hair on face.

Nomada cuneata Rob. University Campus, fls. *Taraxacum; Miss Edna Baker.*

N. bella Cress., var. Boulder, fls. *Nothocalais; Mrs. Bennett.*

N. ednæ Ckll. Campus of University, fls. *Taraxacum,* April 10; *Miss Edna Baker.* In table of Rocky Mtn. *Nomada* runs to *superba,* but much smaller, and apical plate notched.

Osmia universitatis Ckll. University Campus, fls. *Taraxacum,* April 10; *Miss Edna Baker.* Male runs in table near *proxima,* but much larger, legs black, abdomen bright steel-blue, the hind margins of the segments dark purple.

O. leonis Ckll. University Campus, fls. *Taraxacum,* May 8; *Miss Edna Baker.* Near to *gaillardiæ,* but with a shining pit next to apical margin of clypeus; hair of thorax above light ochreous, with a little black.

O. gaudiosa Ckll. University Campus, fls. *Taraxacum,* April 10; *Miss Edna Baker.* A small bright-green species, with white pubescence; posterior part of abdomen dorsally with wholly light hair.

O. ednæ Ckll. University Campus, fls. *Taraxacum,* May 9; *Miss Edna Baker.* Allied to *gaudiosa,* but larger, pubescence very yellow; abdomen brilliant, shining golden.

O. bennettæ Ckll. University Campus, fls. *Taraxacum,* May 8; *Mrs. C. Bennett.* Allied to *O. bella,* but no dark hairs intermixed on thorax above. Easily known from *gaudiosa* and *ednæ* by larger size, and black hair on posterior dorsal region of abdomen.

Full descriptions of the new species are about to be published in *Annals & Mag. Nat. History.*

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THE PROTOZOA OF THE UNIVERSITY CAMPUS

[Dr. C. H. Edmondson, of the Iowa Wesleyan University, having very kindly offered to work up Protozoa from Boulder, I sent him a small collection of material from the University campus. It all came from the south end of the lake or pond, and from the little marsh immediately south of it, across the road. The number of species reported is so great that it seems worth while to put them on record; and in so doing, I have thrown the list into the form of a key. The characters in the key are derived from Dr. Edmondson's recent excellent work on the Protozoa of Iowa (*Proc. Davenp. Acad. Sci.*, 1906), and in part from Dr. H. W. Conn's *Protozoa of the Fresh Waters of Connecticut* (1905). Dr. Edmondson reports that there were in the gathering a few other species which he did not recognize, and to which he well give further study. The Protozoa of Colorado have hitherto been known from the list given by Professor Arthur E. Beardsley in *Trans. Amer. Micr. Society*, May 1902. This list includes 99 species, of which four are described as new. The list from the University campus includes 45 species, of which 20 are ostensibly absent from Professor Beardsley's list; these are marked below with an asterisk. This would bring the Colorado list up to 119, but there is doubtless some synonymy involved. In writing *Amœba proteus* Leidy, I follow Edmondson and Conn, but according to the rules of nomenclature this name is not valid. Stiles and Hassall (*Bureau of Animal Industry, U. S. Dept. Agric.*, Bull 79, 1905, p. 38) have discussed this matter at some length, arriving at the conclusion, on the principle of "tautonomy," that the animal is entitled to the designation *Chaos chaos* (L.). However, on the "first species" principle, and also on that of "elimination," the generic name *Chaos* does not apply to the amœba, and it is questionable whether it ought to be adopted. Discarding *Chaos*, the name *Amiba*, Bory 1822, takes precedence over the altered spelling *Amoeba* Ehrenberg, 1830, and the common species becomes *Amiba chaos* (L.) based on *Volvox chaos* L., 1758. Beardsley records three other species of the genus from Colorado:

Amiba limax Duj.

Amiba spatula Penard. Having two forms, one radiate, floating, 10–12 μ diameter, the other spatulate, crawling, 20–25 μ diameter.

Amiba radiosa Ehr., with long, slender, pointed pseudopodia; diameter of body up to 45 μ (*A. chaos* reaches 250 μ or over).

It is of interest to record that E. Penard, now so well known as an authority on the Rhizopods, was at one time living in Boulder, the guest of Professor John Gardiner. I have not been able to ascertain that he published anything on the Protozoa of Colorado. T. D. A. COCKERELL]

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With or without shells, with pseudopodia lobose, finger-like or raylike and sometimes anastomosing, with or without axial supports (Class *Sarcodina*) . 1.
Small forms provided with one or more flagella; often forming colonies (Class *Mastigophora*) . . . . . 5.
With cilia during embryonic and adult life, or (in Subclass *Suctoria*) in embryonic life only (Class *Infusoria*) . . . . . 10.

1. Without shells. Pseudopodia lobose or sharp-pointed, sometimes branched (Family *Amœbidæ*) . . . . . 2.
With membranous shells with which may be incorporated foreign materials. Pseudopodia lobose or short-pointed, often branched (Family *Arcellidæ*) . . 3.
Shells of plates of chitin or silica, sometimes spined. Pseudopodia sharp-pointed, often branched but not anastomosing (Family *Euglyphidæ*) . . . . 4.

2. Body of comparatively large size; pseudopodia finger-like or lobose (very abundant) **Amœba proteus** Leidy

3. Shell oval or pear-shaped, sometimes with a short neck and broadly expanded fundus with or without spines, composed mainly of sand-grains **Difflugia pyriformis** Perty
Shell usually of some shade of yellow or brown, about one-half as high as broad, the character of the surface varied; mouth circular, in the center of the ventral surface . . . . . **Arcella vulgaris** Ehr.
Shell a delicate, transparent membrane, exceedingly flexible; endoplasm colorless (very abundant) . . . . . **Cochlipodium bilimbosum** Leidy*

4. Shell composed of oval plates overlapping each other and arranged in regular rows producing the appearance of hexagonal areas; spines often present **Euglypha alveolata** Duj.
Body inclosed within an elongated, chitinous shell; fundus rounded, oval extremity narrower and obliquely truncate . . . . . **Trinema enchelys** Leidy*

5. Flagella one or two, at the base of which is a mouth; often possessing chlorophyll (Order *Euglenida*) . . . . . 6.
Plantlike flagellates; flagella two; body elongate-oval, anterior margin with a prominent liplike projection; endoplasm usually including dark-colored corpuscles **Chilomonas paramœcium** Ehr. (Order *Phytoflagellida*)
Body with two transverse furrows; furrow extending wholly round body (Order *Diniferida* or *Dinoflagellata*). . . . . **Gymnodinium** sp.*

6. Elongated forms usually with a single flagellum; pigment spot and chlorophyll often developed (Fam. *Euglenidæ*) . . . . . 7.
Body elongated but plastic, with no coloring substance; flagellum single; length of extended body 30–60 μ . . . . . **Astasia trichophora** Ehr.
Body persistent in shape and plastic; pharynx distinct; oval, somewhat flattened; flagella two; length of body 22 μ. . . . . **Entosiphon sulcatus** Duj.*
Persistent in shape; flagella two, the trailing one very short; ovate, the anterior border acutely rounded, the posterior truncate; length of body 12 μ **Notosolenus opocamptus** Stokes*

7. Body elongate, changeable in form; endoplasm usually bright green in color; eye-spot usually present; flagellum single . . . . . 8.

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Body flattened, leaflike, with a tail-like posterior prolongation; color usually green; eye-spot present; flagellum single . . . . . 9.

8. Body usually rounded anteriorly, with a colorless tail-like posterior prolongation; length of body 50–75 μ . . . . . **Euglena viridis** Ehr.[1]
Body elongate, wormlike; color green; length when extended 50–100 μ **Euglena deses** Ehr.*

9. Body flattened, oval in outline, with a short posterior tail-like projection, usually curved; surface longitudinally striated; endoplasm bright green **Phacus pleuronectes** Müll.
Body with a long tapering tail-like projection, usually straight; endoplasm green **Phacus longicaudus** Ehr.*

10. With cilia during entire existence (Subclass *Ciliata*) . . . . . 11.
With cilia during embryonic life only; with suctorial or piercing tentacles during adult life (Subclass *Suctoria*) . . . . . 28.

11. Cilia usually covering the entire body, sometimes slightly longer about the oral aperture; trichocysts often present (Order *Holotricha*) . . . . 12.
Body entirely ciliate, cilia of the oral region longer than those of the general surface and often fused together (Order *Heterotricha*) . . . . 24.
Usually flattened, with cilia confined to the ventral surface (Order *Hypotricha*) 25.
Cilia reduced to one or two wreaths or circles; stalked forms (Order *Peritricha*) 26.

12. With sculptured shell made of numerous pieces; ovate or barrel-shaped, cylindrical, length 60 μ . . . . . **Coleps hirtus** Ehr.
Without shell . . . . . 13.

13. Cilia uniform over body . . . . . 14.
With a single row of large cilia . . . . . **Mesodinium** sp.*
Cilia only on ventral surface . . . . . 22.

14. Mouth without protruding undulating membrane . . . . . 15.
Mouth with protruding undulating membrane . . . . . 20.

15. Mouth terminal or nearly so; no proboscis . . . . . 16.
Mouth somewhat posterior to anterior end, on the ventral surface; no proboscis 18.

16. With a long neck; not flattened; neck capable of being extended many times the length of the body (very abundant) . . . . . **Lacrymaria olor** Müll.
Without a neck; pharynx long and evident . . . . . 17.

17. Mouth terminal, provided with minute rodlike teeth; length of body 150–200 μ **Prorodon teres** Ehr.
Mouth eccentric, opening into a conical tube which reaches far into the endoplasm **Prorodon edentatus** C. & L.*

18. Mouth in middle, or posterior; length 230 μ . . **Paramæcium caudatum** Ehr.
Mouth anterior to middle . . . . . 19.

19. Elongated oval, wider anteriorly; mouth lateral, appearing as a slotlike opening **Frontonia leucas** Ehr.

[1] In material collected by Lucien Shattuck one or two hundred yards beyond the boundary of the campus we found *Eutreptia viridis* Perty (determined with the assistance of Dr. Edmondson), new to Colorado. It is like an elongate *Euglena*, but with two flagella, and most extraordinary peristaltic movements.

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Elongate, nearly cylindrical, the anterior extremity truncate and slightly curved; length 40–70 μ . . . . . **Loxocephalus granulosus** S. K.*

Elongated, bean-shaped both extremities evenly rounded, the anterior one curved ventrally; length 100–120 μ (very abundant) . . . . **Colpoda helia** Stokes*

Dr. Edmondson also reports a second species of this genus . . **C. campyla** Stokes*

20. Peristome not evident; mouth near the front; body oval, 75 μ long **Glaucoma scintillans** Ehr.

Persitome evident, posterior to middle; a tuft of long bristles at the posterior end; length 30 μ . . . . . **Cinetochilum margaritaceum** Ehr.

Peristome evident, not, or not wholly, posterior to middle . . . 21.

21. Peristome covering the whole right side, with a large membrane; length 50–100 μ **Lembadion bullinum** Perty

Small (20 μ), ovate, with a posterior seta much longer than the cilia of the general surface (very abundant) . . . . . **Cyclidium glaucoma** Ehr.

22. Elongated, with a necklike prolongation . . . . . 23.

Elongated-oval, without a neck; cilia arranged in longitudinal rows **Chilodon cucullulus** Müll.

23. Larger (length 110 μ), contractile vesicle single, posterior (very abundant) **Lionotus fasciola** Ehr.

Smaller (80–100 μ), contractile vesicles numerous **Lionotus pleurosigma** Stokes*

24. Mouth near or posterior to middle of body, preceded by a narrow peristomal furrow; greatly elongated but highly contractile, contracting spirally (very abundant) . . . . . **Spirostomum teres** C. & L.*

Peristome occupying the front border; body entirely ciliate; body blue, when extended 250–300 μ long; often in clusters . . . . . **Stentor cæruleus** Ehr.

Body with anterior ring of cilia; shape spheroidal, length 25 μ **Halteria grandinella** Müll.

25. Elongated-oval or elliptical, very elastic; three prominent frontal styles, and five anal styles; length 80–100 μ . . . . . **Oxytricha pellionella** Müll.

Persistent in shape, inflexible, oval, ventral surface flattened, dorsal surface convex and longitudinally furrowed; seven frontal styles and three ventral; length 80 μ (very abundant) . . . . . **Euplotes charon** Müll.

Small (35 μ); convex dorsal surface with five or six longitudinal furrows; usually three frontal styles, four or five scattered ventral and five anal **Aspidisca costata** Duj.

26. Stalk not retractile, slender, dichotomously branched, secondary divisions very long . . . . . **Epistylis plicatilis** Ehr.*

Stalk retractile . . . . . 27.

27. Body broadly campanulate, greatly dilated anteriorly; stalk usually five or six times length of body; endoplasm dark granular, often opaque; length of body 150 μ **Vorticella campanula** Ehr.*

Body oval, wider centrally, anterior border not greatly dilated: stalk about three times length of body; endoplasm transparent; length of body 55 μ; occurring in social groups . . . . . **Vorticella alba** From.*

Body conical, elongate, tapering posteriorly; stalk not much longer than body; length of body 40–50 μ; solitary in its habits . . **Vorticella telescopa** S. K.*

28. Body inhabiting a lorica which is produced posteriorly into a rigid stalk **Acineta** sp.*

Spherical, without a shell, attached by a slender but rigid stalk; diameter of body 55 μ (very abundant) . . . . . **Podophrya fixa** Müll.*

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